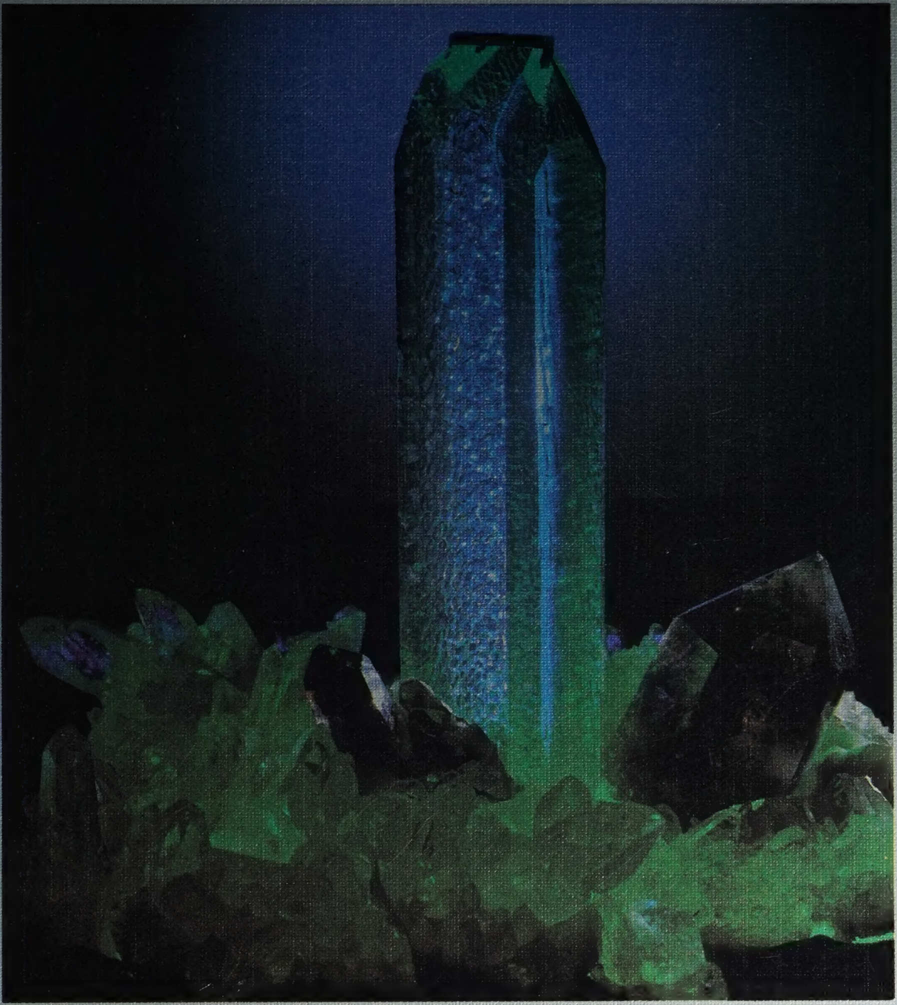

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FOX

QUARTZ CRYSTAL PRODUCTS

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FOX ELECTRONICS

VOLUME 14 NUMBER 1

WHAT'S NEW AT FOX ELECTRONICS?
WE ARE INTRODUCING MAJOR NEW PRODUCTS IN THIS CATALOG!

LOOK TO THE FOX

Industry's Smallest

Tri-State
Surface Mount
Clock Oscillator
F3345 -F3355

page 60-61

Industry's First 3.3 Volt Oscillator

3.3 Volt Oscillator
Surface Mount
Tri-State
F4000

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Industry's Hot New Item

Programmable Oscillators
F6151 & F6053A

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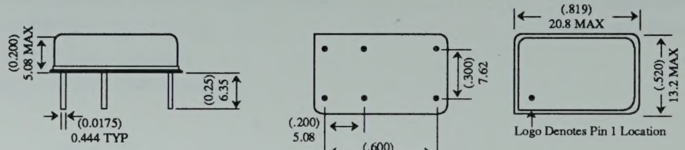
F6053A / TRI-STATE HCMOS PROGRAMMABLE CLOCK OSCILLATOR

The F6053A is a user-programmable tri-state clock oscillator which provides frequency selection between 360kHz - 120MHz at the point of application. The use of the "MUXREF" function allows a glitch-free "on the fly" change in frequency. For some specific applications, see table below.

FEATURES

Programmability
Glitch-Free Frequency Transition
HCMOS Levels
Tri-State Enable/Disable

Preliminary



Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

Pin Connections

#1 Data In	**#8 Output**
#3 Serial-CLK Input	**#12 MUXREF (E/D) ***
#7 GND (Case)	**#14 V_{DD}**

• F6053A OPERATING CONDITIONS

Output Frequency Range		(F_O)	0.360 ~ 120.0	MHz
Temperature Range -	Operating	(T_A)	0 ~ +70	°C
	Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage **		(V_{DD})	5.0 ±0.25	V

*** Enable / Disable Function**

$\overline{\text{INH}}$ (Pin 12)	OUTPUT (Pin 8)
N.C. [a]	ACTIVE
$V_{IH} \geq 2.0$ V	ACTIVE
$V_{IL} \leq 0.8$ V	High Z

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V, CL = max load)

PARAMETERS	FREQUENCY RANGE	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		T_A = 0 ~ 70°C	-100		+100	PPM
Input Current (I_{DD})		TYP @ 50MHz	13	20	40	mA
Output Symmetry	.360 ~ 70 MHz	1.4V level	45		55	%
	70+ ~ 120 MHz		40		60	
Rise Time (t_4)		0.4V ~ 3.85V			5.0	ns
Fall Time (t_5)		3.85V ~ 0.4V			5.0	
Output Voltage (V_{OL})		I_{OL} = 4 mA			0.4	V
(V_{OH})		I_{OH} = -4 mA	3.85			
Output Current (I_{OL})		Logic '0' Level	4.0			mA
(I_{OH})		Logic '1' Level			-4.0	
Output Load	.360 ~ 50 MHz	TTL load			10	TTL
	50+ ~ 80 MHz				5	
	80+ ~ 120 MHz				2	
	.360 ~ 120 MHz	HCMOS load			15	pF

• APPLICATIONS

General Purpose Oscillator - eliminate the stocking of multiple frequencies.
Electrical Engineering - a tool box of oscillators for the electrical engineer. Skew oscillators frequency (e.g. ±10%) to perform worst case evaluation of systems.
CPU Oscillator retrofit -- slow Lap Top Computers oscillator speed to consume less power, or speed it up to produce higher performance.
Hard Disk Drives - vary frequency according to the radius of the drive to allow storage of up to one-third more data.
Graphic Board Dot Clocks - allow dynamic synchronization of different monitors or display resolutions.

** Vcc ramp time = 10 ms min. to guarantee enable function is initially active.
[a] An internal pullup resistor from pin 12 to pin 14 allows active output if pin 12 is floating.
All specifications subject to change without notice. Rev. 1/30/93

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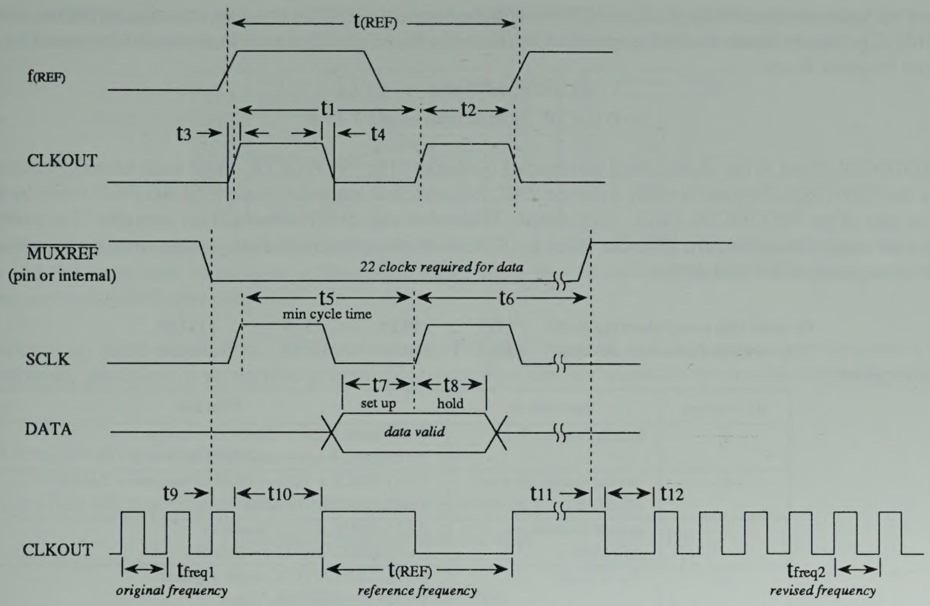
F6053A SERIAL PROGRAMMING TIMING



• AC CHARACTERISTICS (V_{DD} = +5V ±5% 0°C ≤ T_{CASE} ≤ +70°C)

Symbol	Name	Description	Min	Max	Units
$f_{(REF)}$ *	Reference frequency	Reference oscillator = 14.31818 MHz	-100	+100	PPM
$t_{(REF)}$	Reference clock period	$t_{(REF)} = 1 / f_{(REF)}$	69.834	69.848	ns
t_1	output period	CLKOUT oscillator value	8.3 (120 MHz)	2777.8 (360 kHz)	ns
t_2	output duty cycle	t_2 / t_1 measured at 1.5V (.360 ~ 70.000 MHz) (70.000+ ~ 120 MHz)	45 40	55 60	%
t_3	rise time	Rise time for the output oscillator into a 15 pF load		5	ns
t_4	fall time	Fall time for the output oscillator into a 15 pF load		5	ns
t_5	cycle time	Minimum cycle time for the SCLK clock	2 • $t_{(REF)}$		ns
t_6	clk stable	Time required for the CLKOUT oscillator to become valid after last SCLK clock	$t_{(REF)}$	3 • $t_{(REF)}$ +t_{freq2}	ns
t_7	set-up	Time required for the data to be valid prior to the rising edge of SCLK	15		ns
t_8	hold	Time required for the data to remain valid after the rising edge of SCLK	0		ns
t_9	transition	Time for CLKOUT to go low after assertion of MUXREF	0	t_{freq1}	ns
t_{10}	transition	Delay of CLKOUT prior to valid $t_{(REF)}$ signal at output	0.4 $t_{(REF)}$	$t_{(REF)}$	ns
t_{11}	transition	Time for CLKOUT to go low after release of MUXREF	0	$t_{(REF)}$	ns
t_{12}	transition	Delay of CLKOUT prior to valid t_{freq2} signal at output	0.4 t_{freq2}	t_{freq2}	ns

* Other reference frequencies available. Contact Fox Engineering for further information. Rev. 1/30/93

PROGRAMMING THE F6053A

The need for separate registers for the Control Word and the Program Word led to a data encoding technique similar to the HDLC protocol scheme in which a specific bit pattern (the FLAG Field) is used to distinguish between Control Word and Program Word:

FLAG Field (4 bits) = 1 1 1 1
PROTOCOL Field (6 bits) = 0 1 1 1 1 0

The PROTOCOL Field is the FLAG Field surrounded by zeroes. The PROTOCOL Field must be sent in order to activate the CONTROL Register transfer from the TMP Register. It is important that the FLAG Field never be sent except as part of the PROTOCOL Field. **Important: Whenever any programming data contains 3 sequential 1's, the user must bit-stuff a zero after the third 1.** (This is because the FLAG field must be uniquely identifiable by its 4-bit sequence of 1's.) Examples:

To send this programming data:	**1111**	**0111**	**1110**	**111111**
Transmit this serial bit stream:	**10111**	**00111**	**01110**	**01110111**

Control Register

Bit Position	Description	Function
0	Enable Program Word	0 = Program Register Disabled < Default 1 = Program Register Enabled to Receive Data
1	Internal Output Disable / (OUTDIS-)	0 = CLKOUT is VCO or f(REF) Frequency < Default 1 = CLKOUT is Tri-stated
2	Internal Multiplexer (MUXREF-)	0 = CLKOUT is VCO Frequency 1 = CLKOUT is f(REF) < Default
3	Pin 12 usage	0 = Pin 12 is OUTDIS - Input < Default 1 = Pin 12 is MUXREF- Input
4 - 7	Reserved	Must be set to 0 (reserved for future use and manufacturing test)

At power-up, the CONTROL Register is loaded with the following word:

CONTROL Register at Power-up = 0 0 0 0 0 1 0 0

This means that Pin 12 is set to OUTDIS (to allow an automated tester to disable the clock), internal MUXREF is enabled (to force the CLKOUT to the reference frequency prior to programming), internal tri-state is disabled (default is CLKOUT to be generating a clock), and the PROGRAM Register is disabled from loading.

Programming the PROGRAM Register

The F6053A requires a 22-bit programming word (W) to be loaded. This word contains 5 fields:

Programming Word Bit Fields

Field	# of Bits	Notes
P Counter value (P')	7	MSB (Most Significant Bits)
Reserved (R)	1	set to logic 0
Mux (M)	3	
Q Counter Value (Q')	7	
Index (I)	4	LSB (Least Significant Bits)

The frequency of the programmable oscillator f(VCO) is determined by these fields as follows:

$$P' = \overline{130 - P} \qquad Q' = \overline{129 - Q}$$

$$f_{(VCO)} = (2 * f_{(REF)} * \frac{P}{Q})$$

where $f_{(REF)}$ = Reference frequency (i.e. 14.31818 MHz)

The value of $f_{(vco)}$ must remain between 46 MHz and 120 MHz inclusive. Therefore, for output frequencies below 46 MHz, $f_{(vco)}$ must be brought into range. To accomplish this, a post-VCO Divisor is selected by setting the values of the **Mux field (M)** as follows:

M	Divisor	M	Divisor
000	1	100	16
001	2	101	32
010	4	110	64
011	8	111	128

PROGRAMMING THE F6053A cont'd

The **Index field** (I) is used to preset the VCO to an appropriate range. The value for this field should be chosen from the following table. (Note that this table is referenced to $f_{(VCO)}$ rather than to the desired output frequency.)

I	f (VCO) (MHz)	I	f (VCO) (MHz)	I	f (VCO) (MHz)
0000	Shut down VCO	0110	56.6 - 59.0	1011	74.0 - 75.0
0001	----	0111	59.0 - 60.0	1100	75.0 - 79.0
0010	----	1000	60.0 - 63.7	1101	79.0 - 86.9
0011	----	1001	63.7 - 70.1	1110	86.9 - 95.6
0100	46.0 - 51.0	1010	70.1 - 74.0	1111	95.6 - 120.0
0101	51.0 - 56.6				

If the desired VCO frequency lies on a boundary in the table — in other words, if it is exactly the upper limit of one entry and the lower limit of the next — then either index value may be used (since both limits are tested), but we recommend using the higher one.

To assist with these calculations, FOX provides the FOX2PC program for IBM compatible computers which automatically generates the appropriate programming word from the user's input of the desired output frequency.

VCO Programming Constraints

There are four primary programming constraints the user must be aware of:

$$200\text{ kHz} \le \frac{14.31818\text{ MHz}}{Q} \le 1\text{ MHz} \qquad 4 \le P \le 130$$

$$15 \le Q \le 71$$

$$46\text{ MHz} \le f_{(VCO)} \le 120\text{ MHz}$$

The constraints have to do with trade-offs between optimum speed with lowest noise, VCO stability and factors affecting the loop equation. The factors are listed for completeness; however, by using the above-mentioned FOX2PC program, these constraints become transparent.

(*Note: Standard reference frequency is 14.31818 MHz. Other reference frequencies available. Contact Fox Engineering for further information.)

Program Register Example

The following is an example of the calculations FOX2PC performs. Derive the proper programming word for a 39.5 MHz output frequency, using 14.31818 MHz as the reference frequency. Since 39.5 MHz < 46 MHz, double it to 79.0 MHz. Set M to 001. Set I to 1100. The result:

$$f_{(OUT)} = 39.5 = \left(2 * 14.31818 * \frac{P}{Q}\right) \div 2^m \qquad m = 0 \text{ to } 7$$

$$\text{Since } m = 1, \qquad \frac{P}{Q} = 2.7587$$

Several choices of P and Q are available:

P	Q	f(VCO)	Error (PPM)
69	25	79.0363	460
80	29	78.9969	40
91	33	78.9669	419

Normally, one would choose (P , Q) = (80,29) for the best accuracy (40 PPM). However , we will choose (P , Q) = (91,33) to illustrate bit stuffing.

Therefore:

$$P' = \overline{130 - P} = \overline{130 - 91} = \overline{39} = \overline{0100111} = \overline{1011000} \quad \text{(58 Hex)}$$

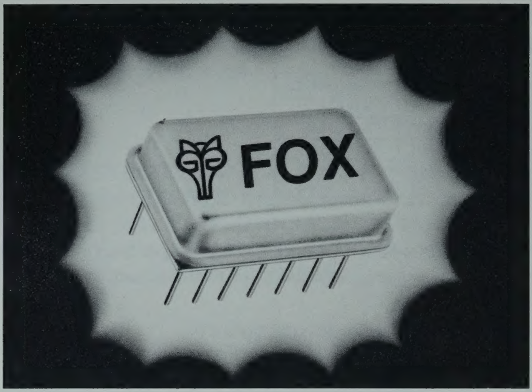
$$Q' = \overline{129 - Q} = \overline{129 - 33} = \overline{96} = \overline{1100000} = \overline{0011111} = 001(0)111(0)1 \quad \text{(05D Hex)}$$

(NOTE: the rightmost bit-stuff is caused by the presence of two 1–bits at the end of the adjoining I field, making, with the first bit of Q', three 1–bits in a row.)

The full programming word, W, is:

W = P', (O), M, Q', I = 1011000, 0, 001, 001011101, 1101 = 101100000010010111011101 (B025DD Hex)

F6151 / TRI-STATE HCMOS DUAL PROGRAMMABLE CLOCK OSCILLATOR

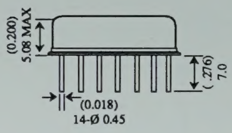


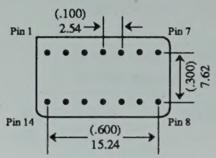
The F6151 is a user-programmable tri-state clock oscillator which provides two independently programmable frequency selections between 320kHz - 115MHz at the point of application. The device also has outputs for Clock A/2, Clock A/4 and a reference frequency (X-BUF). See pin connections below.

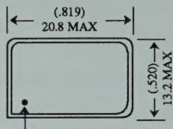
FEATURES

2 Independently Programmable Clock Outputs
Glitch-Free Frequency Transition
HCMOS Levels
Tri-State Enable/Disable
Low Skew ÷ 1, ÷ 2, ÷ 4 Clock Outputs

Preliminary







Logo Denotes Pin 1 Location

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

Pin Connections

#1 N.C. or E/D-A**	# 8 XBUF (Fref)
#2 MUXREF A OUT	# 9 Output B
#3 DATA IN	#10 Output A
#4 Serial-CLKIN B	#11 Output A / 2
#5 MUXREFB OUT	#12 Output A / 4
#6 N.C. or E/D-B**	#13 Serial-CLKIN A
#7 GND (Case)	#14 VDD

• F6151 OPERATING CONDITIONS

Output Frequency Range		(Fo) *	0.320 ~ 115.0	MHz
Temperature Range -	Operating	(TA)	0 ~ +70	°C
	Storage	(TSTG)	-55 ~ +125	°C
Supply Voltage		(VDD)	5.0 ±0.25	V

**** Enable / Disable Function**

$\overline{\text{INH}}$	OUTPUT
N.C. [a]	ACTIVE
$V_{IH} \geq 2.0$ V	ACTIVE
$V_{IL} \leq 0.8$ V	High Z

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V, CL = 15pF)

PARAMETERS	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability	TA = 0 ~ 70°C	-100		+100	PPM
Input Current (IDD)	TYP @ 50MHz	15	50	100	mA
Output Symmetry	.320 ~ 70.000 MHz @ 1.4V	45		55	%
	70.000+ ~ 115.000 MHz @ 1.4V	40		60	
Rise Time (t3)	0.4V ~ 3.85V; MAX Load			5.0	ns
Fall Time (t4)	3.85V ~ 0.4V; MAX Load			5.0	
Output Voltage (VOL)	IOL = 4 mA			0.4	V
(VOH)	IOH = -4 mA	3.85			
Output Current (IOL)	Logic '0' Level	4.0			mA
(IOH)	Logic '1' Level			-4.0	
Output Load	HCMOS			15	pF
	TTL			5	gates

• APPLICATIONS

General Purpose Oscillator - eliminate the stocking of multiple frequencies.
Electrical Engineering - a tool box of oscillators for the electrical engineer. Skew oscillators frequency (e.g. ±10%) to perform worst case evaluation of systems.
CPU Oscillator retrofit -- slow Lap Top Computers oscillator speed to consume less power, or speed it up to produce higher performance.
Hard Disk Drives - vary frequency according to the radius of the drive to allow storage of up to one-third more data.
Graphic Board Dot Clocks - allow dynamic synchronization of different monitors or display resolutions.

* $f(out) = (2 * f(ref) * P/Q) \div 2^m$ where $4 \leq P \leq 130$, $15 \leq Q \leq 71$, $m = 0,1, \ldots, 7$, $f(ref) = 14.31818$ MHz.
[a] Internal pullup resistors from pin 1 or Pin 6 to pin 14 allow active outputs if pin 1 or Pin 6 are left open.
All specifications subject to change without notice. Rev. 1/30/93

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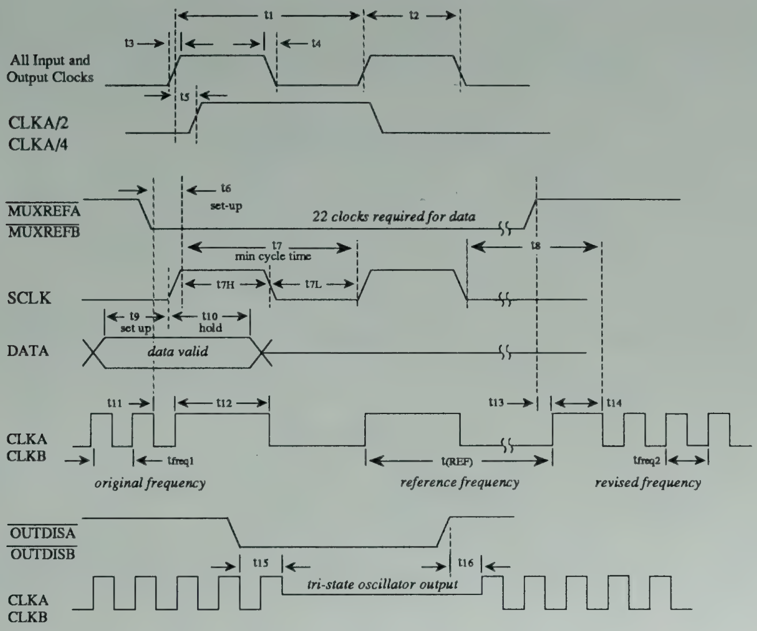
F6151 SERIAL PROGRAMMING TIMING



• AC CHARACTERISTICS (V_{DD} = +5V ±5% 0°C ≤ T_{CASE} ≤ +70°C)

Symbol	Name	Description	Min	Max	Units
$f_{(REF)}$ *	Reference frequency	Reference oscillator = 14.31818 MHz	-100	+100	PPM
t_1	Reference clock period	$t_{(REF)} = 1 / f_{(REF)}$	69.834	69.848	ns
t_2	output duty cycle	t_2 / t_1 measured at 1.5V (.320 ~ 70.000 MHz) (70.000+ ~ 115MHz)	45 40	55 60	%
t_3	rise time	Rise time for the output oscillator into a 15 pF load		3	ns
t_4	fall time	Fall time for the output oscillator into a 15 pF load		3	ns
t_5	CLKA/2/4 skew	Skew delay between the CLKA output and the CLKA/2 and CLKA/4 outputs		2	ns
t_6	set-up	Delay required after MUXREF goes low prior to starting the SCLK clock line	t_{freq1}		ns
t_7	cycle time	Minimum cycle time for the SCLK clock	$2 / t_1$		ns
t_{7H}	high time	Minimum high time for the SCLK clock	$1 / t_1$		ns
t_{7L}	low time	Minimum low time for the SCLK clock	$1 / t_1$		ns
t_8	clk stable	Time required for CLKA or CLKB oscillator to become valid after last SCLK clock		10	ms
t_9	set-up	Time required for the data to be valid prior to the rising edge of SCLK	10		ns
t_{10}	hold	Time required for the data to remain valid after the rising edge of SCLK	5		ns
t_{11}	transition	Time for CLKA or CLKB to go high after assertion of MUXREF	0	t_{freq1}	ns
t_{12}	transition	Delay of CLKA or CLKB prior to valid tref signal at output	1/2 $t_{(REF)}$	3/2 $t_{(REF)}$	ns
t_{13}	transition	Time for CLKA or CLKB to go high after release of MUXREF	0	$t_{(REF)}$	ns
t_{14}	transition	Delay of CLKA or CLKB prior to valid t_{freq2} signal at output	1/2 t_{freq2}	3/2 t_{freq2}	ns
t_{15}	tri-state	Time for the output oscillators to go into tri-state mode after OUTDIS- signal assertion		12	ns
t_{16}	clk valid	Time for the outputs to recover from tri-state mode after OUTDIS- signal goes high		12	ns

* Other reference frequencies available. Contact Fox Engineering for further information. Rev. 1/30/93

PROGRAMMING THE F6151

The desired output frequency is defined via a serial interface, with a 22–bit number shifted in. The F6151 has two programmable oscillators (CLKA and CLKB), requiring a 22–bit programming word (W) to be loaded into each channel independently. This word contains 5 fields:

Programming Word Bit Fields

Field	# of Bits	Notes
Index (I)	4	MSB (Most Significant Bits)
P Counter value (P')	7	
Reserved (R)	1	normally set to logic 1
Mux (M)	3	
Q Counter Value (Q')	7	LSB (Least Significant Bits)

The frequency of the programmable oscillator f(VCO) is determined by these fields as follows:

$$P' = \overline{130 - P} \qquad Q' = \overline{129 - Q}$$

$$f_{(VCO)} = (2 * f_{(REF)} * \frac{P}{Q})$$

where f(REF) = Reference frequency (i.e. 14.31818 MHz)

The value of f(VCO) must remain between 40 MHz and 115 MHz inclusive. Therefore, for output frequencies below 40 MHz, f(VCO) must be brought into range. To accomplish this, a post-VCO Divisor is selected by setting the values of the Mux field (M) as follows:

M	Divisor	M	Divisor
000	1	100	16
001	2	101	32
010	4	110	64
011	8	111	128

The Index field (I) is used to preset the VCO to an appropriate range. The value for this field should be chosen from the following table. (Note that this table is referenced to the VCO frequency f(VCO) rather than to the desired output frequency.)

I	f (VCO) (MHz)	I	f (VCO) (MHz)	I	f (VCO) (MHz)
0000	40.0 – 42.5	0110	68.5 – 69.0	1011	92.1 – 105.0
0001	42.5 – 47.5	0111	69.0 – 84.0	1100	105.0 – 115.0
0010	47.5 – 53.5	1000	84.0 – 87.0	1101	115.0 – 115.0
0011	53.5 – 58.5	1001	87.0 – 92.0	1110	115.0 – 115.0
0100	58.5 – 62.5	1010	92.0 – 92.1	1111	115.0 – 115.0
0101	62.5 – 68.5				

If the desired VCO frequency lies on a boundary in the table — in other words, if it is exactly the upper limit of one entry and the lower limit of the next — then either index value may be used (since both limits are tested), but we recommend using the higher one.

To assist with these calculations, FOX provides the FOX2PC program for IBM compatible computers which automatically generates the correct programming word from the user's input of the desired output frequency.

(continued on following page)

PROGRAMMING THE F6151 (cont'd)

F6151 Programming Constraints

There are four primary programming constraints the user must be aware of:

$$200\text{ kHz} \le \frac{14.31818\text{ MHz}}{Q} \le 1\text{ MHz}$$

$$40\text{ MHz} \le f_{(\mathrm{VCO})} \le 115\text{ MHz}$$

$$4 \le P \le 130$$

$$15 \le Q \le 71$$

The constraints have to do with trade-offs between optimum speed with lowest noise, VCO stability, and factors affecting the loop equation. The above is listed for completeness; however, by using the aforementioned FOX2PC program, these constraints become transparent.

(*Note: Standard reference frequency is 14.31818 MHz. Other reference frequencies available. Contact Fox Engineering for further information.)

F6151 Programming Example

An example of the calculations FOX2PC performs:

Derive the proper programming word for a 39.5 MHz output frequency, using 14.31818 MHz as the reference frequency:

Since 39.5 MHz < 40 MHz, double it to 79.0 MHz. Set M to 001. Set I to 0111. The result:

$$f_{(\mathrm{OUT})} = 39.5 = \left(2 * 14.31818 * \frac{P}{Q}\right) \div 2^{m} \qquad m = 0 \text{ to } 7$$

$$\text{Since } m = 1, \qquad \frac{P}{Q} = 2.7587$$

Several choices of P and Q are available:

P	Q	f(VCO)	Error (PPM)
69	25	79.0363	460
80	29	78.9969	40
91	33	78.9669	419

Choose (P, Q) = (80,29) for best accuracy (40 PPM).

Therefore:

$$P' = \overline{130 - P} = \overline{130 - 80} = \overline{50} = \overline{0110010} = 1001101$$

$$Q' = \overline{129 - Q} = \overline{129 - 29} = \overline{100} = \overline{1100100} = 0011011$$

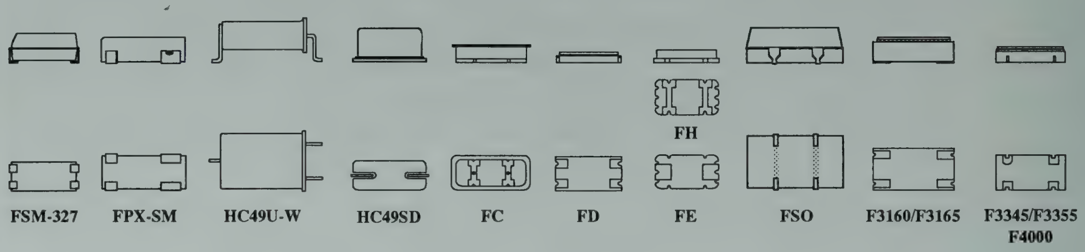
and the full programming word, W, is:

W = I, P', R, M, Q' = 0111, 1001101, 1, 001, 0011011 = 0111100110110010011011

A low-to-high transition on SCLKA/SCLKB (depending on appropriate channel) is used to shift the programming word W into DATA as a serial bit stream, least significant bit (LSB) first. (See the set-up and hold timing specifications elsewhere in this datasheet.) If more than 22 shifts are performed, the last 22 data bits received will be retained.

For further information on the F6151, refer to the FOX2PC data disk or contact the Engineering Department at Fox Electronics.

SURFACE MOUNT / FREQUENCY RANGES BY PRODUCT TYPE



CRYSTALS

FSM-327 32.768kHz

FPX-SM 3.579545 - 70MHz

HC49U-W 1.5 - 175MHz

HC49SD 3.2 - 70MHz

FC 10 - 70MHz

FD 14 - 100MHz

FE / FH 10 - 100MHz

OSCILLATORS

FSO 1.025 - 66.667MHz

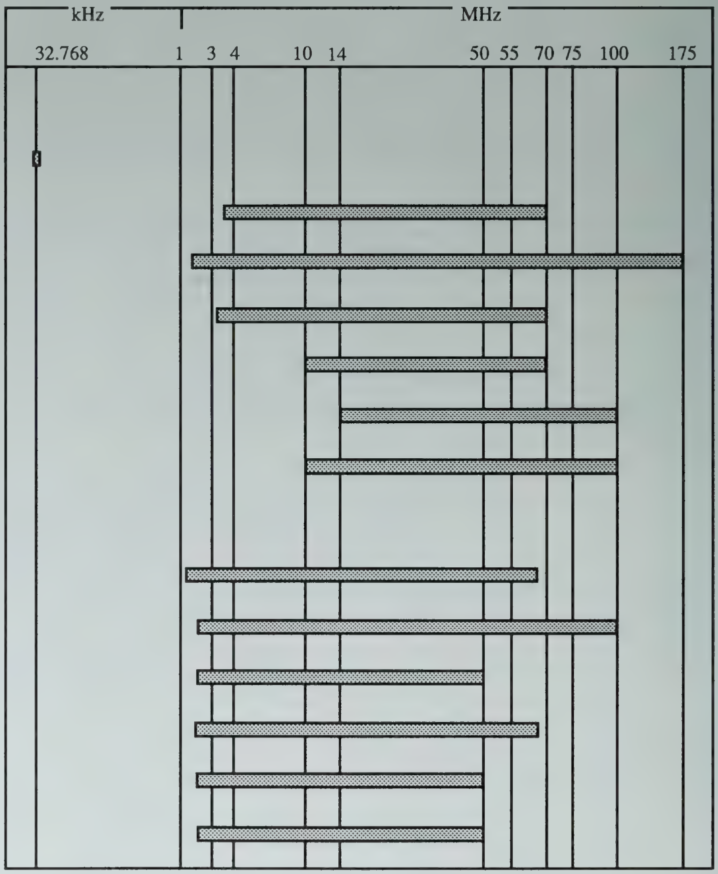
F3160 /F3170 1.8432 - 100MHz

F3165 /F3175 1.8432 - 50MHz

F3345 /F3340 1.8432 - 67MHz

F3355 /F3350 1.8432 - 50MHz

F4000 1.8432 - 50MHz



All specifications subject to change without notice. Rev. 1/30/93

SURFACE MOUNT TECHNOLOGY
PAST, PRESENT AND FUTURE

FOX ELECTRONICS OFFERS MORE PRODUCTS IN MORE SURFACE MOUNT PACKAGES THAN ANY OTHER CRYSTAL AND OSCILLATOR MANUFACTURER

CRYSTALS

A variety of 7 different surface mount crystal products are shown on the following pages with a number of different footprints, profiles, and component materials for your every surface mount need.

Whatever your SMT crystal application may be, Fox Electronics has developed a product in the package size you need with the best electrical parameters the technology will allow. Check us out!

OSCILLATORS

Three different surface mount oscillator package sizes are available from Fox Electronics offering the latest technology for every application. See following pages for dimensions.

NEW IN THIS CATALOG

F3340 - F3345 - F3350 - F3355

Micro Miniature. The smallest oscillator package anywhere!
A high reliability Tri-State part with a wide frequency range for
those low profile, small footprint applications. Available now!

F4000

The very first *3.3 volt oscillator* to be offered in the market.
Same small surface mount package as the F3340 type.
Development is complete, order your samples now!!

F6751 - F6653A

SMD versions of F6151/F6053A

The new programmable oscillator series from Fox Electronics will be available in surface mount packages in 1993. In development now!!

Whatever your surface mount needs, Fox Electronics is dedicated to working to develop the products required for your application.

Let us work with you toward the future.

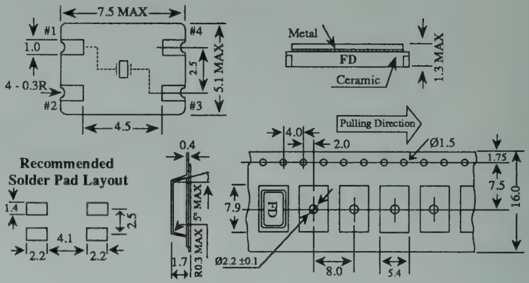
SURFACE MOUNT CRYSTALS

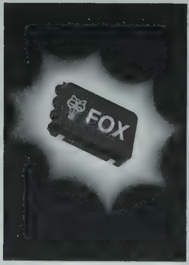
The FD, our smallest SMD Crystal, features 1.3 mm height. *(See pg. 34 - 35 for further information)*

Freq. Range	14 - 100 MHz
Freq. Tolerance	±50PPM @ 25°C
Freq. Stability	±50PPM
Temp. Range	-10°C to +60°C

Pin Connections

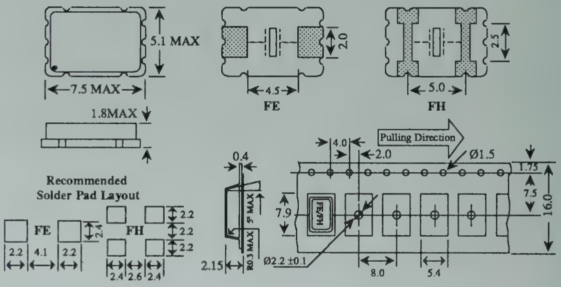
#1 Crystal	#4 GND (Case)
#2 GND (Case)	#3 Crystal





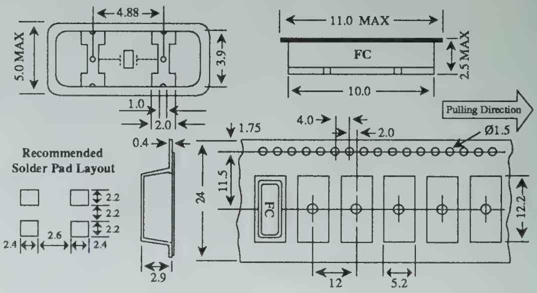
The FE/FH Series offers a low cost epoxy sealed package with a 1.8 mm height and two different land patterns. *(See pg. 36 - 37 for further information)*

Freq. Range	10 - 100 MHz
Freq. Tolerance	±50PPM @ 25°C
Freq. Stability	±50PPM
Temp. Range	-10°C to +60°C



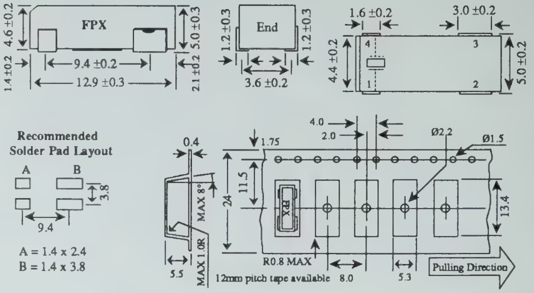
The FC Crystal features 2.5 mm height and is compatible with existing SMT Designs. *(See pg. 32 - 33 for further information)*

Freq. Range	10 - 70 MHz
Freq. Tolerance	±50PPM @ 25°C
Freq. Stability	±50PPM
Temp. Range	-10°C to +60°C



The FPX Crystal features a 5 mm profile and is a cost saving design. *(See pg. 30 - 31 for further information)*

Freq. Range	3.579545 - 70 MHz
Freq. Tolerance	±50PPM @ 25°C
Freq. Stability	±100PPM
Temp. Range	-10°C to +70°C
(Select Freq.)	-40°C to +85°C

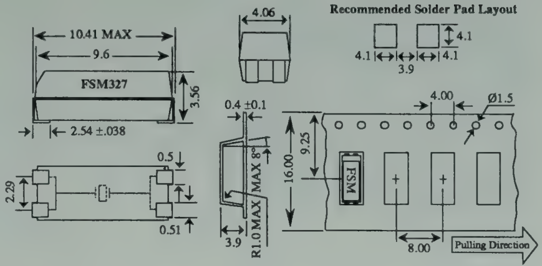


All dimensions in mm

SURFACE MOUNT CRYSTALS

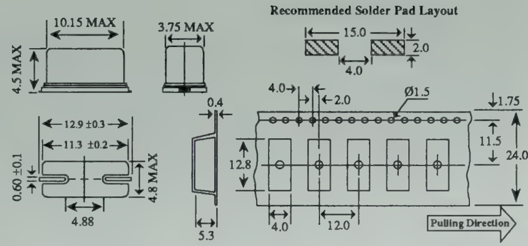
The FSM327 is our SMD Watch Crystal encased in a thermoplastic package built to withstand high temperature soldering techniques. *(See pg. 40 - 41 for further information)*

Frequency	32.768 kHz
Freq. Tolerance	±20PPM @ 25°C
Temp. Range	-40°C to +85°C
Load Capacitance	12.5 pF (std)



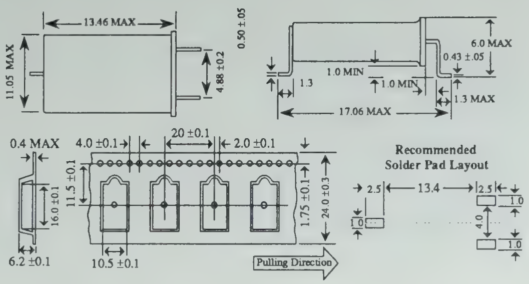
The HC49SD "AT Strip" Crystal provides a low profile, wide frequency range, and a miniature solder pad layout contained in a metal can. *(See pg. 26 - 27 for further information)*

Freq. Range	3.2 - 70 MHz
Freq. Tolerance	±30PPM @ 25°C
Freq. Stability	±50PPM
Temp. Range	0°C to +70°C



The HC49U-W Crystal offers all the same features as the HC49U with the advantage of being surface mountable. *(See pg. 24 - 25 for further information)*

Freq. Range	1.5 - 175 MHz
Freq. Tolerance	±30PPM @ 25°C
Freq. Stability	±50PPM
Temp. Range	-20°C to +70°C



All dimensions in mm

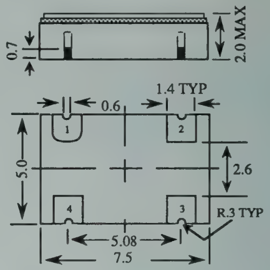
SURFACE MOUNT OSCILLATORS

The F3345/F3340 & F3355/F3350 are ceramic oscillators, perfect for applications such as miniature computers and peripherals, telecommunication devices and instrumentation. Featuring tri-state enable/disable, high capacitive load option, and low EMI. *(See pg. 60 - 61 for further information)*

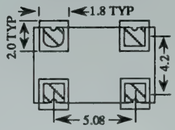
	F3345	**F3355**
Frequency Range	1.8432 ~ 67 MHz	1.8432 ~ 50 MHz
Frequency Stability	±100PPM (F3345) ±50PPM (F3340)	±100PPM (F3355) ±50PPM (F3350)
Operating Temperature	-10°C to +70°C	-10°C to +70°C
Input Current		
1.8432 ~ 25 MHz	25 mA MAX	20mA MAX
25 ~ 50 MHz	45 mA MAX	35mA MAX
50 ~ 67 MHz	60 mA MAX	------
Symmetry @ 2.5 VDC	45/55% MAX	45/55% MAX
Rise/Fall Time	7 ns MAX	10 ns MAX
Output Load	10 TTL or 50 pF	10 LS-TTL or 15 pF

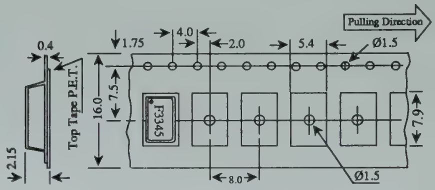
Pin Connections

#1 E/D #3 OUTPUT
#2 GND #4 5VDC

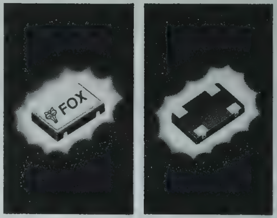


Recommended Solder Pad Layout





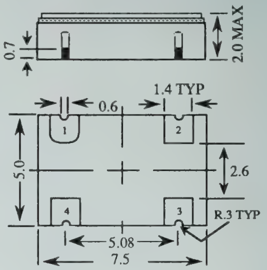
Fox supports the leading edge of technology with a new low-voltage oscillator, the F4000. Among the many benefits of a 3.3V system are an increase in battery life, reduced heat generation and improved EMI, packaged with the low profile necessary for today's advanced portable PC and instrumentation designs. *(See pg. 62 - 63 for further information)*



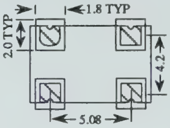
	F4000
Frequency Range	1.8432 ~ 50.000 MHz
Frequency Stability	±100PPM
Operating Temperature	-10°C to +70°C
Input Current	
1.8432 ~ 32.000 MHz	12.0 mA MAX
32.000+ ~ 50.000 MHz	16.5 mA MAX
Symmetry	45/55% MAX
Rise/Fall Time	7 ns MAX
Output Load - HCMOS	15 pF

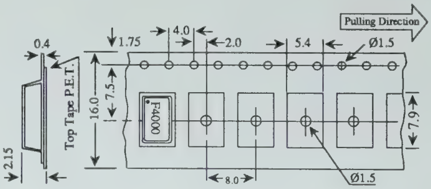
Pin Connections

#1 E/D #3 OUTPUT
#2 GND #4 3.3VDC



Recommended Solder Pad Layout

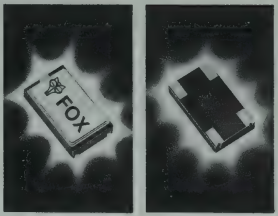




All dimensions in mm

SURFACE MOUNT OSCILLATORS

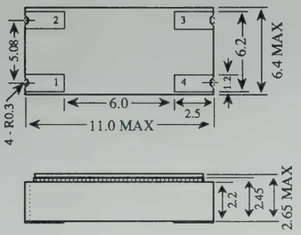
The F3160 / F3170 & F3165 / F3175 are ceramic oscillators which can drive both HCMOS and TTL loads in high density applications. Features include tri-state enable/disable, industry compatible pinout, and low noise. *(See pg. 58 - 59 for further information)*



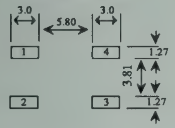
	F3160	F3165
Frequency Range	1.8432 - 100 MHz	1.8432 - 50 MHz
Frequency Stability	±100PPM ±50PPM (F3170)	±100PPM ±50PPM (F3175)
Operating Temperature	-10°C to +70°C	-10°C to +70°C
Input Current		
1.8432 ~ 25 MHz	25 mA MAX	20 mA MAX
25 ~ 50 MHz	45 mA MAX	35 mA MAX
50 ~ 70 MHz	70 mA MAX	-----
70 ~ 100 MHz	80 mA MAX	-----
Symmetry @ 2.5 VDC	40/60% MAX	45/55% MAX
Rise/Fall Time		
1.8432 ~ 70 MHz	7 ns MAX	10 ns MAX
70+ ~ 100 MHz	3ns MAX	-----
Output Load		
1.8432 ~ 70 MHz	10 TTL	10 LSTTL
1.8432 ~ 100 MHz	50 pF	15 pF

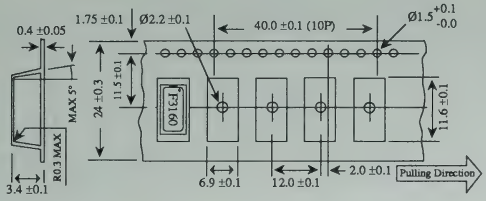
Pin Connections

#1 E/D #3 Output
#2 GND #4 +5 VDC

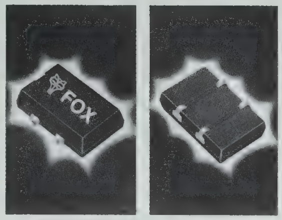


Recommended Solder Pad Layout





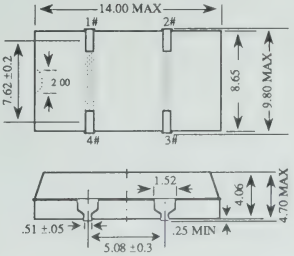
The FSO Series Oscillator is compatible with both TTL and HCMOS technologies. Features include extended temperature range, 5000 G shock resistance, and tri-state enable/disable option. Enable option FSO-2, FSO-2T, and FSO-2H. *(See pg. 56 - 57 for further information)*



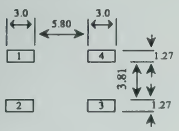
	FSO / FSO-2	FSO-T/FSO-2T	FSO-H	FSO-2H
Frequency Range	1.025 - 26 MHz	26 - 36 MHz	30 - 55 MHz	26 - 66.667 MHz
Frequency Stability				
-10°C to +70°C	±100PPM	±100PPM	±100PPM	±100PPM
-40°C to +85°C	±200PPM	±200PPM		
Input Current				
No Load	23 mA MAX	35 mA MAX	35 mA MAX	35 mA MAX
Disabled (-2, -2T, -2H only)	12 mA MAX	20 mA MAX	--------	20 mA MAX
Symmetry	40/60% MAX	40/60% MAX	40/60% MAX	40/60% MAX
Rise/Fall Time	8 ns MAX	10 ns MAX	7 ns MAX	7 ns MAX
Output Load	10 TTL or 50 pF	10 TTL or 30 pF	10 LS-TTL or 50 pF	50 pF

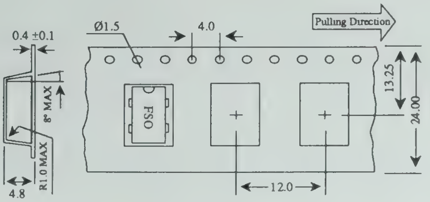
Pin Connections

#1 E/D or N.C. #3 Output
#2 GND #4 +5 VDC



Recommended Solder Pad Layout





All dimensions in mm

FAST FOX

Call Customer Service For

Quality Quick!

Quartz Crystals

(HC49U & HC50U)

Oscillators

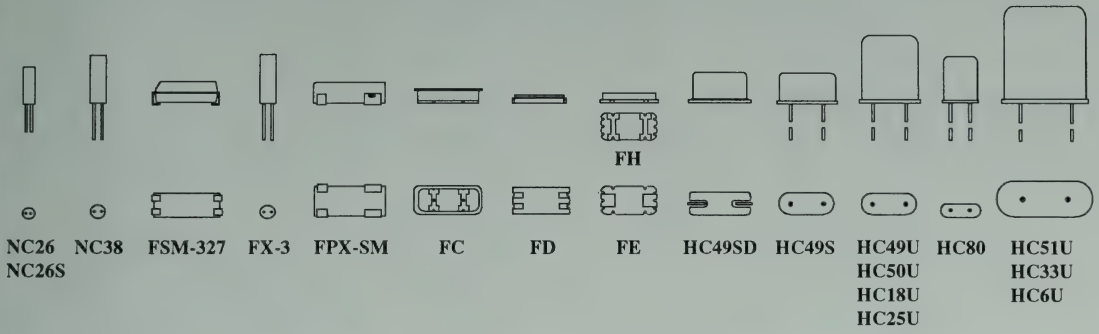
(F1100E, F1100H, H5C-2, F5C-2, F3020, F3000)

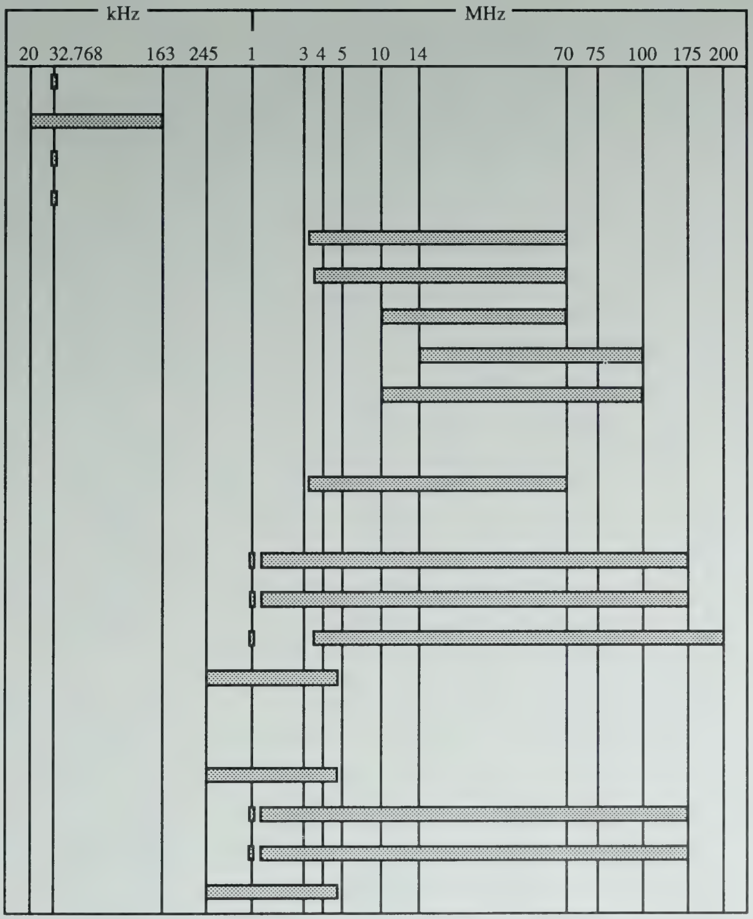
Premium Service at a Reasonable Price

Delivery :	From 3 to 15 working days
Frequencies:	3 to 27 MHz fundamental crystals 30 - 60 MHz 3rd overtone crystals F1100E 4 - 25 MHz oscillators F1100H 4 - 70 MHz oscillators H5C-2 1.8432 - 50 MHz oscillators F5C-2 1.8432 - 50 MHz oscillators F3020 1.8432 - 70 MHz oscillators* F3000 1.8432 - 70 MHz oscillators* *Selected frequencies between 60MHz to 70MHz
Quantity:	Call for pricing & delivery confirmation

Let Fast Fox help you with your "Rush" Requirements
1 (800) 741-8758

CRYSTALS / FREQUENCY RANGES BY PRODUCT TYPE





NC26 Tuning Fork 32.768kHz

NC26S Tuning Fork 20kHz - 163kHz

NC38 Tuning Fork 32.768kHz

FSM-327 Tuning Fork 32.768kHz

FX-3 "AT Strip" 3.2 - 70MHz

FPX 3.579545 - 70MHz

FC 10 - 70MHz

FD 14 - 100MHz

FE / FH 10 - 100MHz

RESISTANCE WELD

HC49S "AT Strip" 3.2 - 70MHz
(HC49SD Surface Mount)

HC49U "AT" Cut ***

HC50U "AT" Cut ***

HC80 "AT" Cut **

HC51U "AT" Cut *

SOLDER SEAL

HC6U "AT" Cut *

HC18U "AT" Cut ***

HC25U "AT" Cut ***

HC33U "AT" Cut *

* "AT" Cut 800 kHz - 4.8 MHz
** "AT" Cut 3.579545 MHz - 200 MHz "SL" Cut 1.000 MHz - 1.048576 MHz
*** "AT" Cut 1.5 MHz - 175 MHz "SL" Cut 1.000 MHz - 1.048576 MHz
All specifications subject to change without notice. Rev. 1/30/93

INFORMATION REQUIRED FOR ORDERING SPECIAL FREQUENCIES AND MICROPROCESSOR CRYSTALS

Standard Fox Crystals can be ordered from our catalog by using Fox Part Numbers. See page 22 for standard crystal ordering form. If special crystals are required other than the frequencies and specifications in our catalog, the following is needed:

(Copy this sheet and send to Fox)

1. a) Customer Name: ______________________________

b) Address: ______________________________

c) Phone: ______________________________

d) FAX: ______________________________

2. Frequency ____________ (MHz)

3. Circuit condition: Series ______ Parallel ______ If Parallel, specify Load Capacitance (C_L) _____ pF (picofarads)

4. a) Holder Type ____________

b) Standard Markings (HC49U)
Line 1 - Fox Standard µP part number or just "FOX" if a custom crystal
Line 2 - Frequency

c) Special Options
______ X - Designates third lead on top of can
______ V - Designates an insulating vinyl sleeve
______ MS - Designates a mylar spacer on the base of the crystal to insulate the base from circuit traces
______ W - Gullwing (HC49U only) Surface Mount

d) Special Marking per customer's drawing ______________________________

5. Oscillation Mode: (circle one) FUNDAMENTAL 3RD OVERTONE 5TH OVERTONE 7TH OVERTONE

6. Maximum Series Resistance (ESR) __________ (ohms)

7. a) Frequency Tolerance @ 25°C ± _______ PPM or ± _______ %

b) Frequency Stability through Temp. Range ± _______PPM or ± _______%

c) Operating Temp. Range_______°C to _______ °C

8. Maximum Drive Level ____________

9. Application: (if available, please attach circuit schematic:) ______________________________

Sample quantity required: ______________________________

Order quantity required: ______________________________

Production schedule: ______________________________

Microprocessor chip model number and manufacturer: ______________________________

☐ CHECK THIS BOX FOR FREE ENGINEERING SAMPLES BASED ON INFORMATION SUPPLIED ABOVE

CUSTOM MADE CRYSTALS

Package Styles				
Seal	**Lead Type**	**Large**	**STD**	**Miniature**
Resistance Weld	Wire	HC51U	HC49U	HC80U
	Pin	HC48U	HC50U	----------
Solder Seal	Wire	HC33U	HC18U	----------
	Pin	HC6U	HC25U	----------
Cold Weld	Wire	HC47U	HC43U	HC45U
	Pin	----------	HC42U	----------
Oscillation Mode	Fundamental	.25-4.8 MHz	1-30 MHz	1-30 MHz
	Overtone	N/A	20-175 MHz	25-175 MHz

Specifications	
Frequency Tolerance @ 25°C (±2°C)	10 to 100PPM
Operating Temperature Ranges	-10°C to +60°C -20°C to +70°C -30°C to +80°C -40°C to +85°C
Freq. Stability over Operating Temp. Range	10 to 100PPM
Load Capacitance (TYP)	12 pF to 50 pF & Series
Aging Rate per Year	1 to 7PPM
Drive Level	0.1 mW (TYP)

All specifications subject to change without notice.

QUARTZ CRYSTAL ORDERING GUIDE

This guide was developed to assist anyone in your organization to better understand the use of a crystal in a microprocessor application, regardless of their technical training. Each paragraph is numbered to correspond with the numbers on the information sheet (facing page) for ordering and quoting.

1. Please enter your company information. Fox maintains a customer database so updated specifications and new product information can be mailed.

2. **Frequency** - Since the crystal is the "clock" function of the microprocessor, the frequency is critical to the equipment designer in order to accomplish the commands in the circuit within the time frame required. Note that our standard 2MHz (megahertz) crystal is called FOX020 & our 20MHz crystal is a FOX200 .

3. **Circuit Condition** - For crystals used in series circuits, load capacitance is not applicable. The load capacitance of parallel circuits should be specified in picofarads (pF). 20 pF and 32 pF load capacitance are common requirements. This is very important ordering information.

4. **Holder Type** (can size) - Standard sizes are the HC18U/HC49U and HC33U/HC51U with wire leads. Low frequency, large diameter crystals are supplied in the larger holders (HC33U & HC51U). The size of the holder is important because it is difficult (at times impossible) to fit lower frequency (larger diameter) crystals into the smaller holders. HC25 & HC6 holders have plug in pins rather than wire leads. Third lead option is available on top of the holder; this is used to secure the holder to the board and is commonly referred to as third lead, hold down strap, ground lead, or PC board pin. If there is a request for special part number marking, the holder can be marked on both sides or top (top marking only if no third lead is added).

5. **Oscillation Mode** - A quartz crystal is designed to vibrate on its fundamental frequency or one of its overtones. This becomes important between the 24MHz to 30MHz range. Crystals in that frequency range may be made as either a high fundamental or a low 3rd overtone. Fundamental mode crystals at these frequencies become very expensive as the quartz blank is extremely thin, difficult to handle, and subject to a higher rate of breakage in processing. If the customer is able to use the 3rd overtone crystal instead of the fundamental, his cost savings may be significant. As the frequency range is extended, the oscillation mode of the crystal changes to other overtones. Crystals in the range of 60-110MHz are generally 5th overtones, while crystals in the range of 110-140MHz generally are 7th overtones. (Please specify mode necessary for your application.)

6. **Maximum Series Resistance** (ohms) - Standard resistance values are supplied in our literature. If lower resistance values are required, the crystals are more difficult to make and more expensive to produce. Specify if other than standard values are needed.

7. **Temperature** - Crystals are the key component in an oscillator circuit and they are affected by ambient conditions, particularly the temperature. Our standard specification for tolerance at room temperature (+25°C) is ±30 parts per million (PPM) or ±.003%. As the temperature changes from room temperature, frequency is affected. Standard MPU stability from -20°C to +70°C is ±50PPM or .005% referenced to the 25°C value. This is very critical ordering information. Tighter tolerances or wider temperature ranges will raise the price.

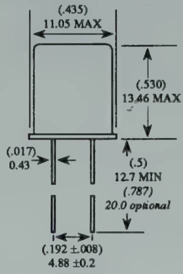
8. **Drive Level** - Is the amount of power dissipation experienced by the crystal in a given operating circuit and is expressed in milliwatts or microwatts. Excessive drive level will result in possible fracture of the quartz resonator or excessive long-term drift. An indication of excessive drive level is a constant upward frequency drift. Our test drive level is 0.1 mW.

9. Please enter all possible information for the use of the crystals you are ordering. This includes the application, quantities for sampling and production, and when production will begin.

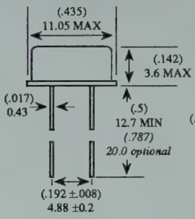
Our engineering department will review the information and determine the appropriate crystal for your needs.

STANDARD MICROPROCESSOR CRYSTALS

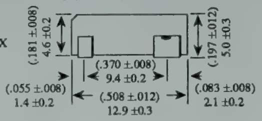
HC49U RESISTANCE WELD



HC49S
RESISTANCE WELD



FPX
SURFACE MOUNT



FOX STANDARD SPECIFICATIONS

PARAMETER	HC49U*	HC49S**	FPX
Frequency Tolerance @ 25°C	±30PPM	±30PPM	±50PPM
Frequency Stability over Operating Temperature	±50PPM	±50PPM	±100PPM
Operating Temperature Range	-20°C to +70°C	0°C to +70°C	-10°C to +70°C

* Optional third lead, vinyl sleeves, and mylar spacer.
** Optional third lead and mylar spacer.
All specifications subject to change without notice.

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

Rev. 1/30/92

FREQUENCY (MHz)	*CL*	*49U / PART#*	*ESR (ohms) MAX*	*49S / PART#*	*ESR (ohms) MAX*	*FPX / PART#*	*ESR (ohms) MAX*
1.000 ***	SERIES	FOX010S	3000	----	----	----	----
1.8432	13 PF	FOX018S	800	----	----	----	----
2.000	20 PF	FOX020S	500	----	----	----	----
2.097152	20 PF	FOX021S	500	----	----	----	----
2.4576	32 PF	FOX024S	300	----	----	----	----
3.000	32 PF	FOX030S	200	----	----	----	----
3.2768	18 PF	FOX032S	120	----	----	----	----
3.579545	18 PF	FOX036S	120	FOXS/036S	200	FPX036S	200
3.6864	SERIES	FOX0368S	120	FOXS/0368S	200	FPX0368S	200
3.6864	20 PF	FOX0368-20	120	FOXS/0368-20	200	FPX0368-20	200
4.000	SERIES	FOX040A	100	FOXS/040A	150	FPX040A	150
4.000	20 PF	FOX040	100	FOXS/040	150	FPX040	150
4.032	22 PF	FOX0432	100	----	----	FPX0432	150
4.194304	12 PF	FOX041	100	FOXS/041	150	FPX041	150
4.433619	20 PF	FOX0443	70	FOXS/0443	150	FPX0443	150
4.9152	SERIES	FOX049	55	FOXS/049	150	FPX049	150
4.9152	20 PF	FOX049-20	55	FOXS/049-20	150	FPX049-20	150
5.000	20 PF	FOX05A	50	FOXS/05A	120	FPX05A	120
5.0688	SERIES	FOX050	50	FOXS/050	120	FPX050	120
5.185	20 PF	----	----	----	----	FPX051	120
6.000	SERIES	FOX060	40	FOXS/060	100	FPX060	100
6.000	20 PF	FOX060-20	40	FOXS/060-20	100	FPX060-20	100
6.144	30 PF	FOX061	40	FOXS/061	100	FPX061	100
6.144	20 PF	FOX061-20	40	----	----	----	----
6.5536	20 PF	----	----	----	----	FPX065	100
7.3728	SERIES	FOX073	40	FOXS/073	80	FPX073	80
7.3728	20 PF	FOX073-20	40	FOXS/073-20	80	FPX073-20	80
8.000	SERIES	FOX080	35	FOXS/080	80	FPX080	80
8.000	20 PF	FOX080-20	35	FOXS/080-20	80	FPX080-20	80
8.192	SERIES	FOX081	35	FOXS/081	80	----	----
8.192	20 PF	FOX081-20	35	FOXS/081-20	80	----	----
9.600	SERIES	FOX096	35	----	----	----	----
9.8304	SERIES	FOX098	35	FOXS/098	60	----	----
9.8304	20 PF	FOX098-20	35	FOXS/098-20	60	----	----
10.000	SERIES	FOX100	30	FOXS/100	60	FPX100	60
10.000	20 PF	FOX100-20	30	FOXS/100-20	60	FPX100-20	60
10.738635	SERIES	----	----	----	----	FPX107	60
10.738635	20 PF	----	----	----	----	FPX107-20	60
11.000	SERIES	FOX111	30	FOXS/111	60	FPX111	60
11.000	20 PF	FOX111-20	30	FOXS/111-20	60	FPX111-20	60
11.0592	SERIES	FOX115	30	FOXS/115	60	FPX115	60
11.0592	20 PF	FOX115-20	30	FOXS/115-20	60	FPX115-20	60
12.000	SERIES	FOX120	30	FOXS/120	60	FPX120	60
12.000	20 PF	FOX120-20	30	FOXS/120-20	60	FPX120-20	60
12.288	SERIES	FOX128	30	FOXS/128	60	FPX128	60
12.288	20 PF	FOX128-20	30	FOXS/128-20	60	FPX128-20	60
14.31818	SERIES	FOX143	25	FOXS/143	40	FPX143	50
14.31818	20 PF	FOX143-20	25	FOXS/143-20	40	FPX143-20	50
14.7456	SERIES	FOX147	25	FOXS/147	40	FPX147	50
14.7456	20 PF	FOX147-20	25	FOXS/147-20	40	FPX147-20	50
15.000	SERIES	FOX150	25	----	----	FPX150	50
15.000	20 PF	----	----	----	----	FPX150-20	50
16.000	SERIES	FOX160	25	FOXS/160	40	FPX160	50
16.000	20 PF	FOX160-20	25	FOXS/160-20	40	FPX160-20	50
18.000	SERIES	FOX180	20	----	----	FPX180	50
18.000	20 PF	----	----	----	----	FPX180-20	50
18.432	SERIES	FOX184	20	FOXS/184	40	FPX184	50
18.432	20 PF	FOX184-20	20	FOXS/184-20	40	FPX184-20	50
19.6608	SERIES	FOX196	20	FOXS/196	40	FPX196	50
19.6608	20 PF	FOX196-20	20	FOXS/196-20	40	FPX196-20	50
20.000	SERIES	FOX200	20	FOXS/200	30	FPX200	50
20.000	20 PF	FOX200-20	20	FOXS/200-20	30	FPX200-20	50
22.1184	SERIES	FOX221	20	FOXS/221	30	FPX221	50
22.1184	20 PF	----	----	FOXS/221-20	30	FPX221-20	50
24.000	SERIES	FOX240F	20	FOXS/240F	30	FPX240F	50
24.000	20 PF	FOX240F-20	20	FOXS/240F-20	30	FPX240F-20	50
24.000	SERIES	FOX240 ****	40	----	----	----	----
32.000	SERIES	FOX320 ****	40	----	----	----	----
32.000	20 PF	FOX320-20 ****	40	----	----	----	----
100.000	SERIES	FOX1000 *****	60	----	----	----	----

**** 3rd Overtone
***** 5th Overtone

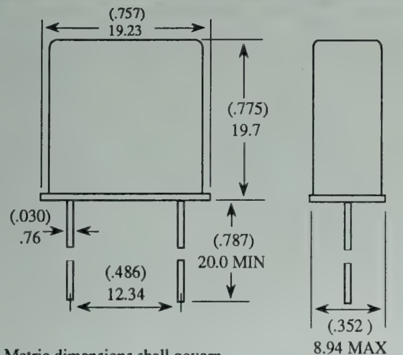
*** Frequency Tolerance = ±1000PPM, Frequency Stability over -10°C to 60°C = ±1000PPM (SL Cut)

HC51U / LOW FREQUENCY CRYSTAL

The HC51U Quartz Crystal Unit is the standard for low frequency applications. With its resistance weld package and large profile, the HC51U can withstand strong vibration and shock requirements and provide high reliability in applications where space is not critical.

FEATURES

"AT" Cut (.800 ~ 4.8 MHz)
Third Lead Option
Excellent Reliability



STANDARD MARKING

Line 1: FOX
Line 2: Frequency

Date Code available on request **
(Year and Week of manufacture - YYWW)

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• HC51U STANDARD SPECIFICATIONS ***

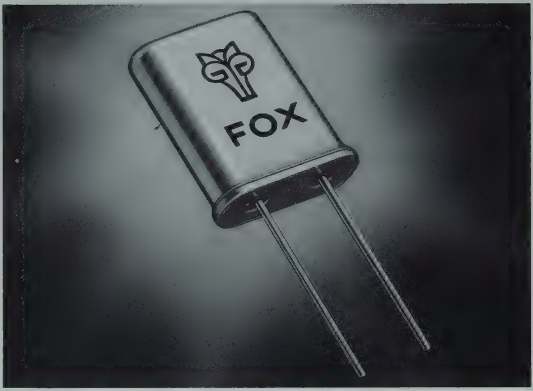
PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range	245 kHz ~ 4.8 MHz	*	0.245		4.800	MHz
Frequency Tolerance	0.800 ~ 1.000 MHz	TA = 25°C	-50		+50	PPM
	1.000+ ~ 4.800 MHz		-30		+30	
Frequency Stability, ref. @ 25°C	0.800 ~ 1.000 MHz	TA = -10 ~ +60°C	-100		+100	PPM
	1.000+ ~ 4.800 MHz		-50		+50	
Temperature Range						
Operating (TA)			-10		+60	°C
Storage (TSTG)			-30		+85	
Shunt Capacitance (Co)					7.0	pF
Drive Level				0.1	5.0	mW
Aging		TA = 25°C ; per year			±7.0	PPM

• EQUIVALENT SERIES RESISTANCE

Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)	Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)
0.800 - 0.999	Fundamental	2k	2.4 - 2.999	Fundamental	250
1.000 - 1.250	Fundamental	800	3.0 - 3.199	Fundamental	150
1.251 - 1.799	Fundamental	500	3.2 - 4.000	Fundamental	120
1.800 - 1.999	Fundamental	400	4.1 - 4.399	Fundamental	80
2.000 - 2.399	Fundamental	300	4.4 - 4.800	Fundamental	70

* Consult the factory for specifications below 800 kHz.
** Specify date code - extra charge.
*** Custom specifications available - consult factory, or use crystal ordering guide on page 20.
Note: Motional arm parameters available on request.
All specifications subject to change without notice. Rev. 1/30/93

HC49U / RESISTANCE WELD CRYSTAL



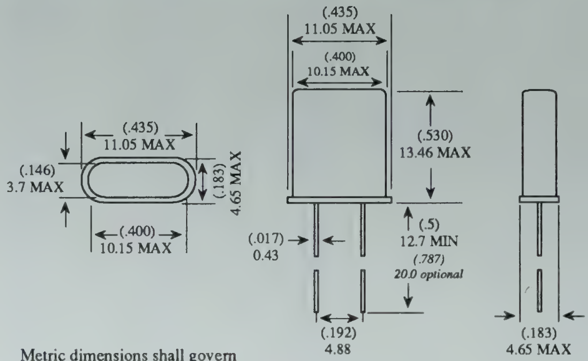
The HC49U Quartz Crystal Unit features a rugged resistance weld package which allows for a better aging factor than its solder seal equivalent, HC18U.

FEATURES

Excellent Aging
Wide Frequency Range
"AT" Cut Crystal

OPTIONS

Surface Mount
Third Lead
Vinyl Sleeve
Mylar Spacer
Tape & Reel *I Radial (Pin -Thru) I Pocket (Surface Mount)*



Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

STANDARD MARKING

Line 1: Standard P/N per page 22 (FOX, if custom)
Line 2: Frequency *i.e. FOX143-20*
14.31818

Date Code available on request *
(Year and Week of manufacture - YYWW)

• HC49U STANDARD SPECIFICATIONS **

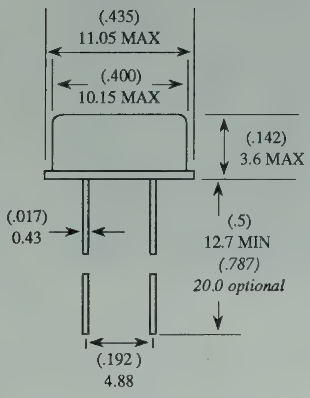
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		1.5		175	MHz
Frequency Tolerance	TA = 25°C	-30		+30	PPM
Frequency Stability, ref. @ 25°C	TA = -20 ~ +70°C	-50		+50	PPM
Temperature Range					
Operating (TA)		-20		+70	°C
Storage (TSTG)		-30		+85	
Shunt Capacitance (CO)				7.0	pF
Drive Level	1.5 ~ 3.00 MHz		0.1	5.0	mW
	3.00 ~ 175.000 MHz		0.1	2.0	
Aging	Ta = 25°C; per year			±5	PPM

• FREQUENCY RANGE / RESISTANCE

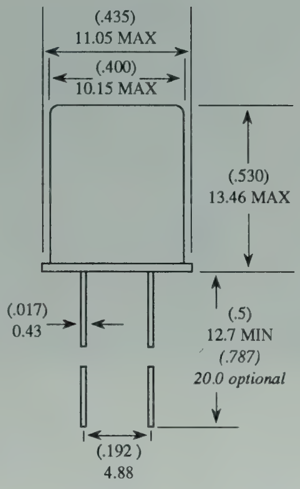
Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)	Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)
1.5 - 1.79	Fundamental	800	5.5 - 5.999	Fundamental	50
1.8 - 1.99	Fundamental	750	6.0 - 7.999	Fundamental	40
2.0 - 2.39	Fundamental	500	8.0 - 9.999	Fundamental	35
2.4 - 2.99	Fundamental	300	10.0 - 12.499	Fundamental	30
3.0 - 3.19	Fundamental	200	12.5 - 16.000	Fundamental	25
3.2 - 3.69	Fundamental	120	16.1 - 25.000	Fundamental	20
3.7 - 4.19	Fundamental	100	15.0 - 65.000	(3rd O/T)	40
4.2 - 4.89	Fundamental	70	60.0 - 109.999	(5th O/T)	80
4.9 - 5.49	Fundamental	50	110.0 - 175.000	(7th O/T)	120

* Specify date code - extra charge.
** Other tolerances, stabilities, and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
All specifications subject to change without notice. Rev. 1/30/93

HC49 PRODUCT LINE



HC49S



HC49U

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

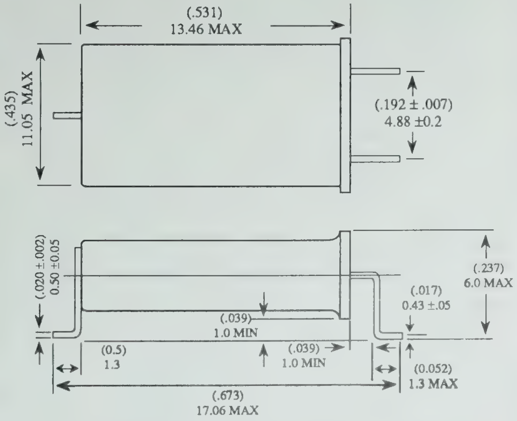
SPECIFICATIONS

	HC49S *	HC49U **
Frequency Range	3.2 MHz to 70 MHz	1.5 MHz to 175 MHz
Frequency Tolerance	±30PPM @ 25°C	±30PPM @ 25°C
Frequency Stability, ref. @ 25°C	±50PPM from 0°C to +70°C	±50PPM from -20°C to +70°C
Operating Temp. Range	0°C to +70°C	-20°C to +70°C
Shunt Capacitance	7 pF (MAX)	7 pF (MAX)

* Available with a center ground lead on base - custom parts only.
** Available with top ground lead.

HC49U-W SURFACE MOUNT GULLWING CONFIGURATION

HC49U-W



Pocket tape and reel now available for this SMT configuration - EIA 481-2
All specifications subject to change without notice. Rev. 1/30/93

HC49S / RESISTANCE WELD LOW PROFILE CRYSTAL

STANDARD HC49S

HC49SD

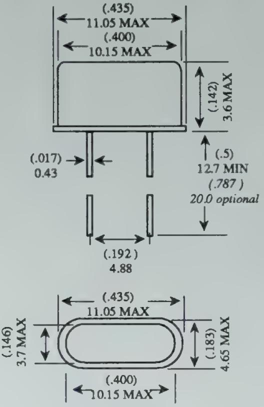
The HC49S has the same lead spacing as the HC49U, but with a 3.6mm height, it suits many space-limited applications. A surface mount version, the HC49SD, is also available.

FEATURES

"AT Strip" Cut
Low Profile
Versatile Pad Layout

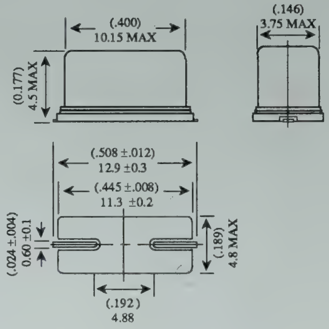
OPTIONS

Third Base Lead *(Leaded)*
Mylar Spacer *(Leaded)*
Tape & Reel
• *Radial (Leaded)*
• *Pocket (Surface Mount)*



HC49S

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches



HC49SD

STANDARD MARKING *

Per standard frequencies on page 22
(i.e. FOXS/143-20 becomes FS143-2)
Custom marking - 7 digits available

• HC49S STANDARD SPECIFICATIONS **

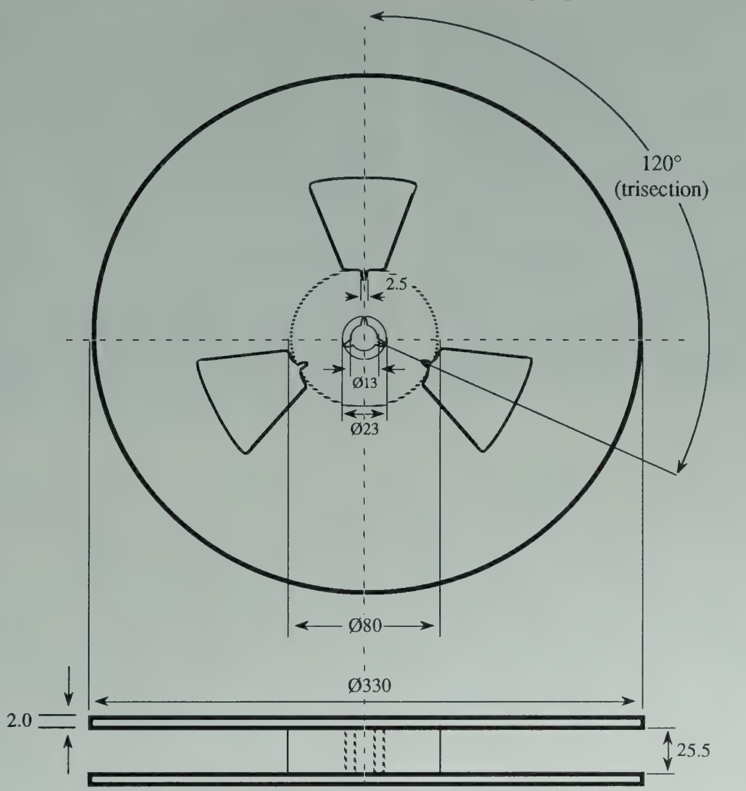
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		3.2		70.000	MHz
Frequency Tolerance	TA = 25°C	-30		+30	PPM
Frequency Stability, ref. @ 25°C	TA = 0 ~ +70°C	-50		+50	PPM
Temperature Range					
Operating (TA)		0		+70	°C
Storage (TSTG)		-30		+85	
Shunt Capacitance (Co)				7.0	pF
Drive Level			0.1	1.0	mW
Aging	Ta = 25°C; per year			±5	PPM

• EQUIVALENT SERIES RESISTANCE

Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)	Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)
3.200 - 3.499	Fundamental	300	7.000 - 8.999	Fundamental	80
3.500 - 3.999	Fundamental	200	9.000 - 12.999	Fundamental	60
4.000 - 4.999	Fundamental	150	13.000 - 19.999	Fundamental	40
5.000 - 5.999	Fundamental	120	20.000 - 30.000	Fundamental	30
6.000 - 6.999	Fundamental	100	27.000+ - 70.000	3rd OT	100

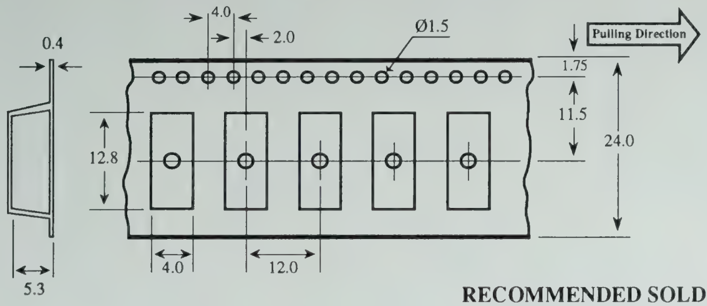
* Date coding available.
** Other tolerances, stabilities and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
Note: Motional arm parameters available on request.
All specifications subject to change without notice. Rev. 1/30/93

HC49SD REEL DIMENSIONS *

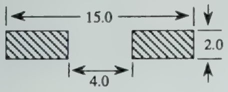


CARRIER TAPE: POLYSTYRENE PARTS QUANTITY PER REEL: 1,000

HC49SD EMBOSSED CARRIER DIMENSIONS *

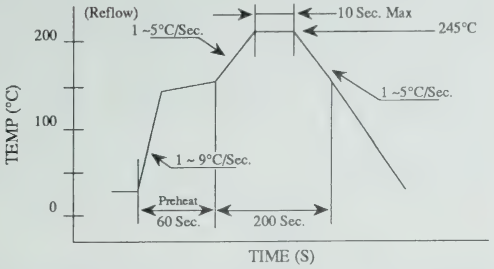


HC49SD RECOMMENDED SOLDER PAD LAYOUT



RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



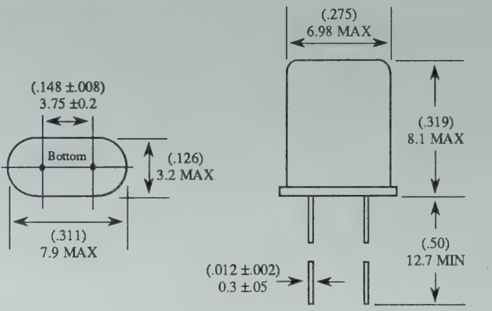
* Meets EIA-481A-2 and EIAJ-1009B
All dimensions are in millimeters.
All specifications subject to change without notice. Rev. 1/30/93

HC80 / MINIATURE CRYSTAL

The HC80 Quartz Crystal is a miniature unit in a resistance welded package that provides for an excellent hermetic seal and frequency aging. This high quality crystal offers a smaller footprint in a broad frequency range, in addition to a low profile which eliminates the need for hold down pins and thereby provides additional savings of labor costs.

FEATURES

Excellent Frequency Aging Characteristics
High Frequency Applications
Low Profile
High Stability
Smaller Footprint than HC49 Series



STANDARD MARKING *

Line 1: FOX
Line 2: Frequency

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• HC80 STANDARD SPECIFICATIONS **

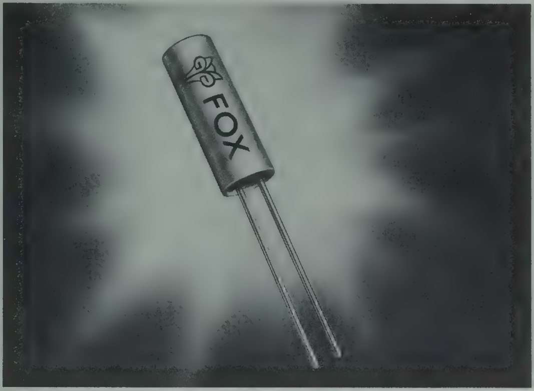
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range	SL-Cut	1.000000		1.048576	MHz
	AT - Cut	3.579545		200.000000	
Frequency Tolerance	TA = 25°C	-30		+30	PPM
Frequency Stability, ref. @ 25°C	TA = -10 ~ +60°C	-50		+50	PPM
Temperature Range					
Operating (TA)		-10		+60	°C
Storage (TSTG)		-40		+85	
Shunt Capacitance (CO)				7.0	pF
Drive Level	3.579545 ~ 200.000 MHz		0.1	1.0	mW
Aging	TA = 25°C; per year			±3.0	PPM

• FREQUENCY RANGE / RESISTANCE

Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)	Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)
1.000000 ~ 1.048576	Fundamental	4K ohms	8.000 ~ 9.999999	Fundamental	90 ohms
3.579545 ~ 3.999999	Fundamental	300 ohms	10.000 ~ 10.999999	Fundamental	60 ohms
4.000000 ~ 4.999999	Fundamental	250 ohms	11.000 ~ 27.000000	Fundamental	40 ohms
5.000000 ~ 5.999999	Fundamental	180 ohms	25.000 ~ 65.000000	3rd Overtone	60 ohms
6.000000 ~ 6.999999	Fundamental	120 ohms	60.000 ~ 130.000000	5th Overtone	100 ohms
7.000000 ~ 7.999999	Fundamental	100 ohms	130.000 ~ 200.000000	7th Overtone	150 ohms

* Date coding available
** Other tolerances, stabilities and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
All specifications subject to change without notice. Rev. 1/30/93

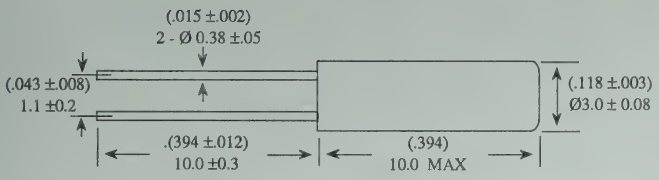
FX-3 / MICRO MINIATURE "AT STRIP" CRYSTAL



The FOX FX-3 "AT Strip" Crystal features miniaturization which makes it perfect for applications requiring small size. In terms of volume, the FX-3 is 75% smaller than the standard HC80 and is 90% smaller than the HC49U, with the smallest footprint of any crystal package.

FEATURES

Miniature Package
High Stability
Rugged Cold Weld Design
High Shock Resistance



STANDARD MARKING *
(7 characters available)
i.e. FX-3 20.000MHz = F20.000

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• FX-3 STANDARD SPECIFICATIONS **

PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		3.200		70.000	MHz
Frequency Tolerance	T_A = 25°C	-50		+50	PPM
Frequency Stability, ref. 25°C	T_A = -20 ~ +70°C	-50		+50	PPM
Temperature Range					°C
Operating (T_A)		-10		+70	
Storage (T_{STG})		-40		+85	
Shunt Capacitance (C_O)				7.0	pF
Drive Level			0.1	1.0	mW
Aging	T_A = 25°C; per year			±5.0	PPM

• FREQUENCY RANGE / RESISTANCE

Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)	Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)
3.200 ~ 3.500	Fundamental	300	7.000+ ~ 9.000	Fundamental	80
3.500+ ~ 4.000	Fundamental	200	9.000+ ~ 13.000	Fundamental	60
4.000+ ~ 5.000	Fundamental	150	13.000+ ~ 20.000	Fundamental	40
5.000+ ~ 6.000	Fundamental	120	20.000+ ~ 30.000	Fundamental	30
6.000+ ~ 7.000	Fundamental	100	28.636 ~ 70.000	(3rd O/T)	100

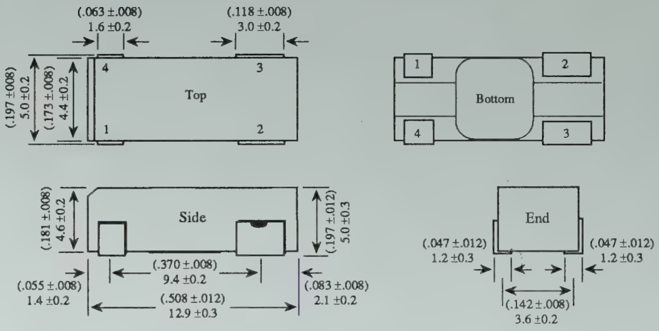
* Date coding available
** Other tolerances, stabilities and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
All specifications subject to change without notice. Rev. 1/30/93

FPX / PLASTIC ENCASED SMD CRYSTAL

The FOX FPX is a surface mount version of the FX-3. It has a special high temperature seal which is able to withstand SMD soldering techniques. The housing for this crystal is made from the same rugged thermoplastic that is standard for integrated circuits. Small size and availability in tape and reel make this product exceptional for SMD applications.

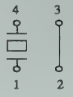
FEATURES

Economical Cost
Space Saving Design
Surface Mount
Tape and Reel



STANDARD MARKING *
Per standard frequencies on page 22
(*i.e. FPX143-20 becomes FP143-2)*
Custom marking 7 characters available

Pad Connections



Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• FPX STANDARD SPECIFICATIONS **

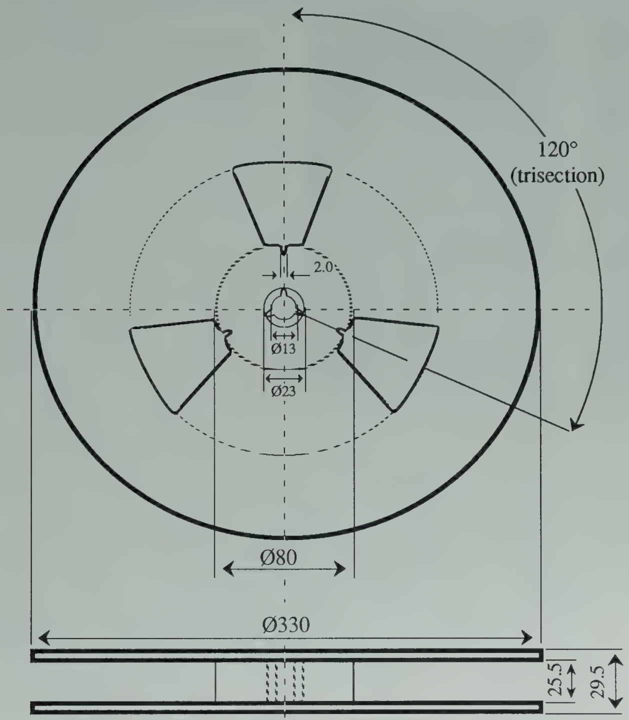
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		3.579545		70.000	MHz
Frequency Tolerance	TA = 25°C	-50		+50	PPM
Frequency Stability, ref. @ 25°C	TA = -10 ~ +70°C	-100		+100	PPM
Temperature Range					
Operating (TA)		-10		+70	°C
Storage (TSTG)		-30		+85	
Shunt Capacitance (Co)				7.0	pF
Drive Level			0.1	1.0	mW
Aging	Ta = 25°C; per year			±5	PPM

• EQUIVALENT SERIES RESISTANCE

Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)	Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)
3.579545 ~ 3.999	Fundamental	200	7.000 ~ 8.999	Fundamental	80
4.000000 ~ 4.999	Fundamental	150	9.000 ~ 12.999	Fundamental	60
5.000000 ~ 5.999	Fundamental	120	13.000 ~ 29.999	Fundamental	50
6.000000 ~ 6.999	Fundamental	100	30.000 ~ 70.000	3rd OT	100

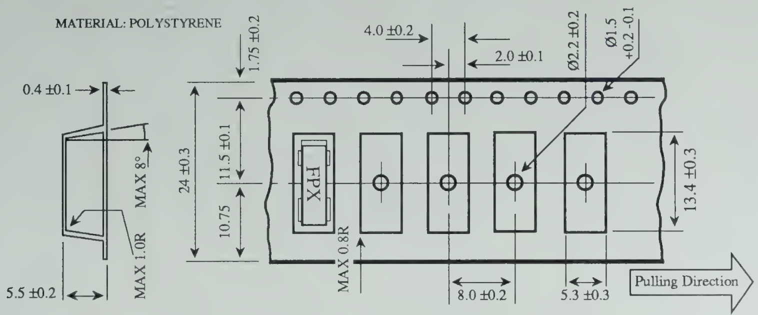
* Date coding available.
** Other tolerances, stabilities and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
Note: Motional arm parameters available on request.
All specifications subject to change without notice. Rev. 1/30/93

FPX REEL DIMENSIONS *



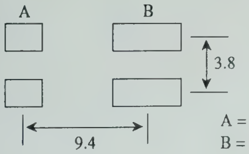
MATERIAL: CARDBOARD PARTS QUANTITY PER REEL: 1,000

FPX EMBOSSED CARRIER DIMENSIONS *



12 mm Pitch Tape available

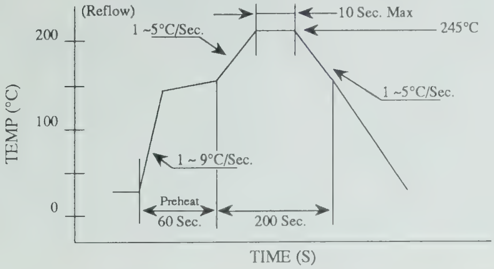
RECOMMENDED SOLDER PAD LAYOUT



A = 1.4 x 2.4
B = 1.4 x 3.8

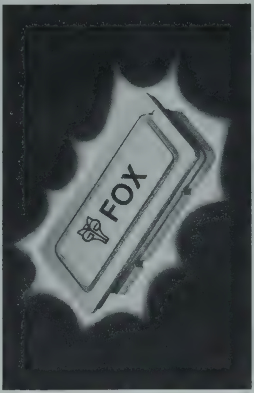
RECOMMENDED SOLDER PROFILE

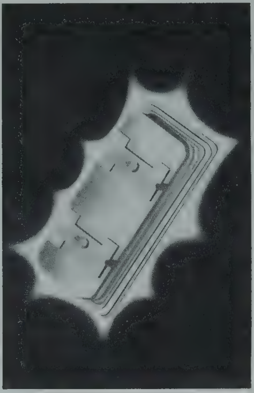
260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



* Meets EIA-481-2
All dimensions are in millimeters.
All specifications subject to change without notice. Rev. 1/30/93

FC / MICRO MINIATURE CERAMIC SMT CRYSTAL



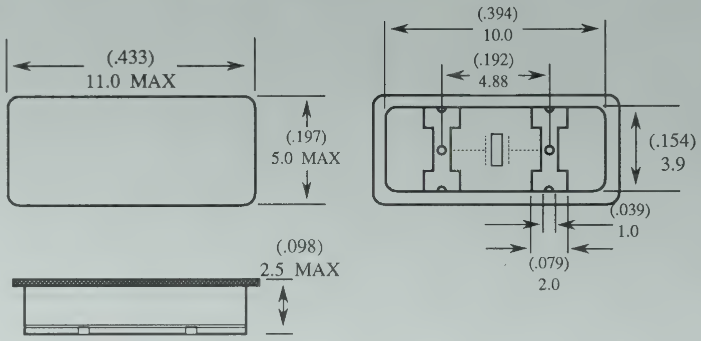


The Fox FC Surface Mount Crystal has a package height of 2.5mm for those applications where the standard FPX is too high.

The package incorporates a ceramic pad with screened patterns for a true SMD footprint.

FEATURES

High Reliability
Competitive Pricing
Compatible with Existing SMT Designs



STANDARD MARKING *
(7 characters available)
i.e. FC 32.000MHz = FC32.00

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• FC STANDARD SPECIFICATIONS **

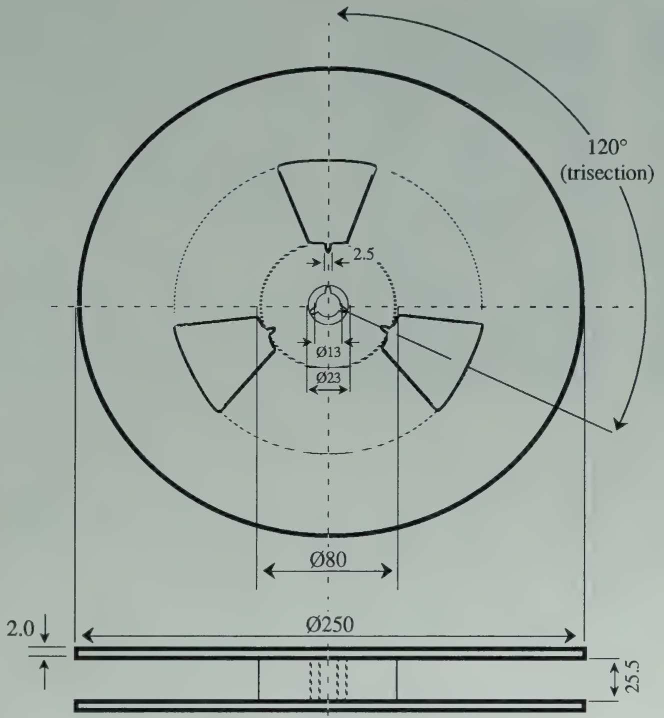
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range ***		10.000		70.000	MHz
Frequency Tolerance	TA = 25°C	-50		+50	PPM
Frequency Stability, ref. @ 25°C	TA = -10 ~ +60°C	-50		+50	PPM
Temperature Range					
Operating (TA)		-10		+60	°C
Storage (TSTG)		-30		+85	
Shunt Capacitance (CO)				7.0	pF
Drive Level			0.1	1.0	mW
Aging	Ta = 25°C; per year			±5.0	PPM

• FREQUENCY RANGE / RESISTANCE

Frequency Range (MHz)	Oper. Mode	ESR Max (Ω)
10.000 ~ 10.999	Fundamental	45
11.000 ~ 11.999	Fundamental	40
12.000 ~ 14.999	Fundamental	35
15.000 ~ 32.000	Fundamental	30
27.000 ~ 70.000	3rd OT	100

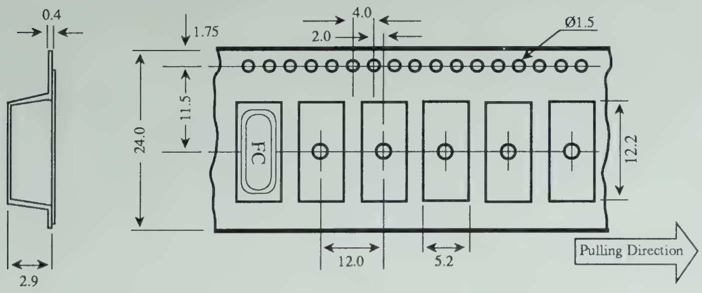
* Date coding available
** Other tolerances, stabilities, and operating temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
*** Selected frequencies from 4.00 ~ 9.999 MHz available by individual inquiry.
Note: Motional arm parameters available on request.
All specifications subject to change without notice. Rev. 1/30/93

FC REEL DIMENSIONS *

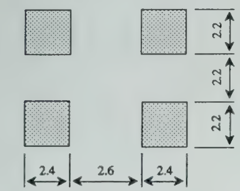


MATERIAL: CARDBOARD PARTS QUANTITY PER REEL: 1,000

FC EMBOSSED CARRIER DIMENSIONS *



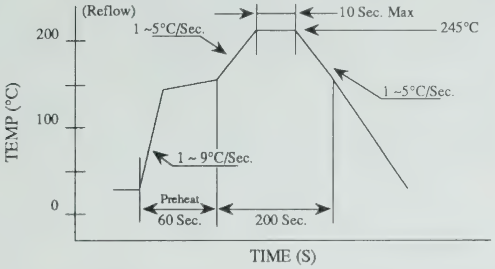
RECOMMENDED SOLDER PAD LAYOUT



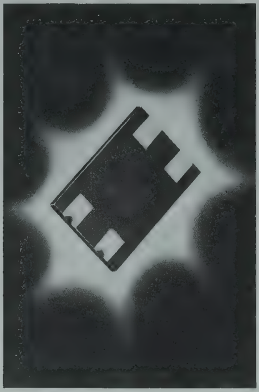
Meets EIA-481A-2 and EIAJ-1009B
All dimensions in millimeters
All specifications subject to change without notice. Rev. 1/30/93

RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



FD / MICRO MINIATURE CERAMIC SMT CRYSTAL

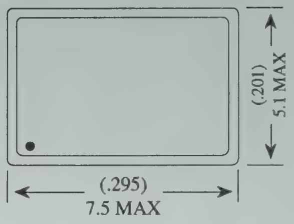


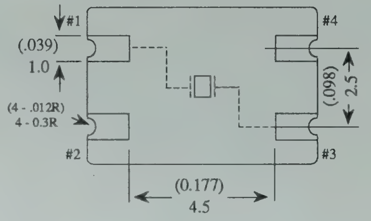
The Fox "FD", our smallest SMD Crystal, features 1.3mm height, a 14MHz to 100MHz frequency range and standard microprocessor parameters for applications such as laptop, notebook, and palm held computers, pocket LAN adapters and disk drives.

An optional 10 PPM part is available in select frequencies for telecommunications and other tight tolerance applications.

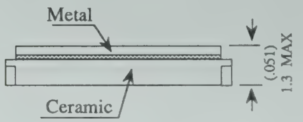
FEATURES

Lowest Profile
Tight Stability
Wide Frequency Range
AT Cut Crystal Blank
Standard Tape and Reel (Qty. 3000)





Pad Connections
#1 Crystal **#4 GND (Case)**
#2 GND (Case) **#3 Crystal**



STANDARD MARKING *
Line 1: 16.000
Line 2: FD

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• FD STANDARD SPECIFICATIONS **

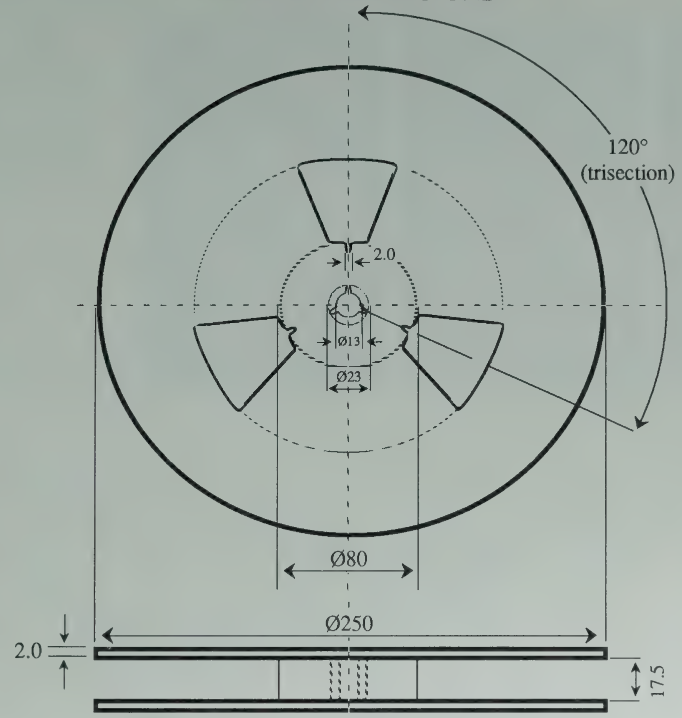
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		14.000		100.000	MHz
Frequency Tolerance	TA = 25°C	-50		+50	PPM
Frequency Stability, ref. @ 25°C	TA = -10 ~ +60°C	-50		+50	PPM
Temperature Range					
Operating (TA)		-10		+60	°C
Storage (TSTG)		-30		+85	
Shunt Capacitance (Co)			2.0 ~ 4.0	7.0	pF
Drive Level			0.1	1.0	mW
Aging	TA = 25°C; per year			±5	PPM

• EQUIVALENT SERIES RESISTANCE

Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)	Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)
14.000 ~ 16.000	Fundamental	60	28.000 ~ 84.000	3rd OT	60
16.000+ ~ 32.000	Fundamental	40	84.000+ ~ 100.000	5th OT	80

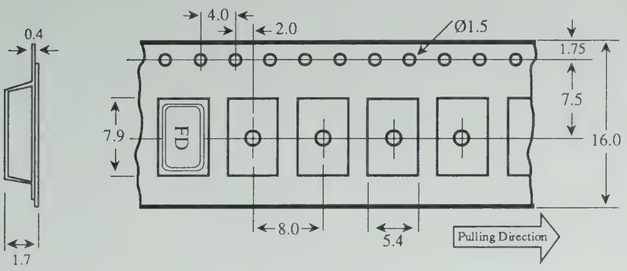
* Date coding available
** Other tolerances, stabilities and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
Note: Motional arm parameters available on request.
All specifications subject to change without notice. Rev. 1/30/93

FD REEL DIMENSIONS *

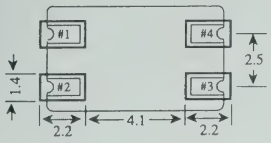


MATERIAL: CARDBOARD PARTS QUANTITY PER REEL: 3,000

FD EMBOSSED CARRIER DIMENSIONS *

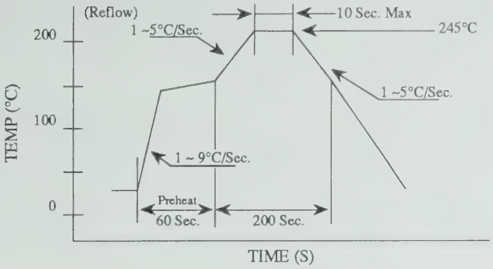


RECOMMENDED SOLDER PAD LAYOUT



RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



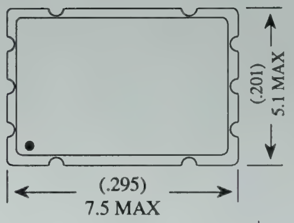
* Meets EIA-481A-2 and EIAJ-1009D
All dimensions in millimeters
All specifications subject to change without notice. Rev. 1/30/93

FE / FH MINIATURE CERAMIC SMT CRYSTALS

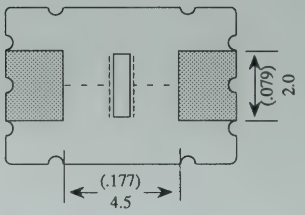
The FE / FH series provides a miniature profile in an epoxy sealed ceramic package. These designs offer low cost and high reliability, two land patterns, and are available in tape and reel.

FEATURES

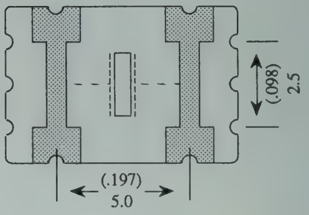
Epoxy Sealed Ceramic Package
Low Cost
Surface Mount
Miniature Size
Wide Frequency Range
Standard Tape & Reel (Qty. 2000)

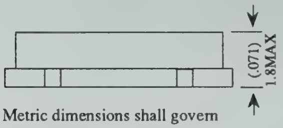


FE



FH





STANDARD MARKING *
Line 1: 16.000
Line 2: FE

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

• FE / FH STANDARD SPECIFICATIONS **

PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		10.000		100.000	MHz
Frequency Tolerance	TA = 25°C	-50		+50	PPM
Frequency Stability, ref. @ 25°C	TA = -10 ~ +60°C	-50		+50	PPM
Temperature Range Operating (TA) Storage (TSTG)		 -10 -30		 +60 +85	°C
Shunt Capacitance (Co)				7.0	pF
Drive Level			0.1	1.0	mW
Aging	TA = 25°C; per year			±5.0	PPM

• EQUIVALENT SERIES RESISTANCE

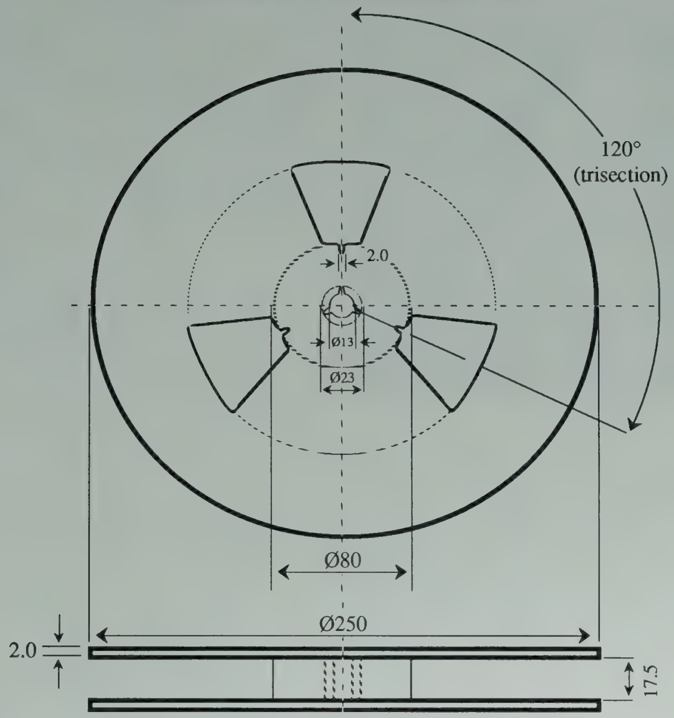
Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)	Frequency Range (MHz)	Oper. Mode	Max ESR (Ω)
10.000 ~ 16.000	Fundamental	60	28.000 ~ 84.000	3rd OT	60
16.000+ ~ 32.000	Fundamental	40	84.000+ ~ 100.000	5th OT	80

• STANDARD FREQUENCIES

10.000	12.000	15.000	16.650	20.000	25.175	29.4912	36.000	50.000
10.245	14.31818	16.000	18.432	22.650	28.000	30.000	40.000	66.666
11.0592	14.7456	16.384	19.6608	24.000	28.322	32.000	48.000	

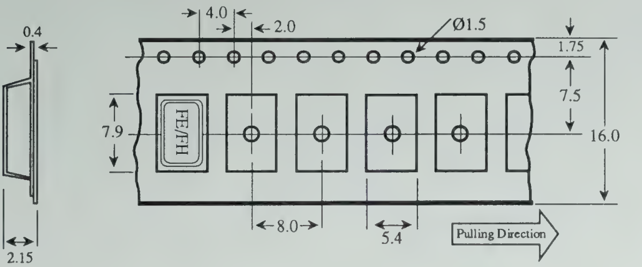
* Date coding available
** Other tolerances, stabilities and temperature ranges available. Consult factory for specific requirements, or use crystal ordering guide on page 20.
Note: Motional arm parameters available on request.
All specifications subject to change without notice. Rev. 1/30/93

FE / FH REEL DIMENSIONS *

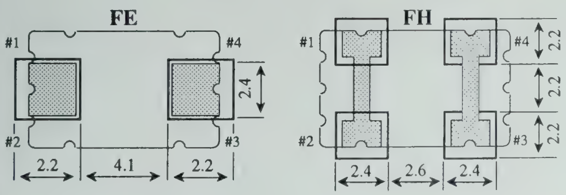


MATERIAL: CARDBOARD PARTS QUANTITY PER REEL: 2,000

FE / FH EMBOSSED CARRIER DIMENSIONS *

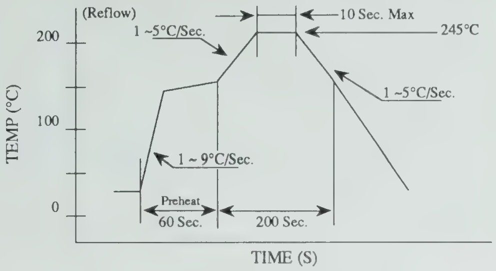


RECOMMENDED SOLDER PAD LAYOUT



RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



* Meets EIA-481A-2 and EIAJ-1009D
All dimensions in millimeters
All specifications subject to change without notice. Rev. 1/30/93

NC26/NC38 / TUNING FORK/WATCH CRYSTALS

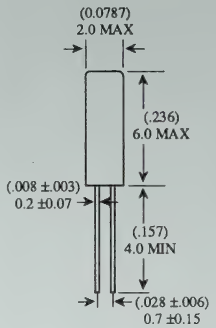
NC26 / NC26S

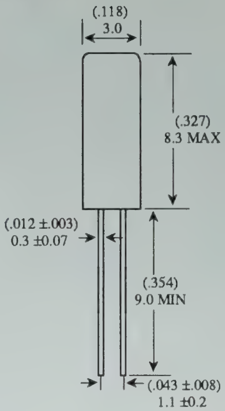
NC38

Fox Electronics offers state of the art technology in tuning fork crystals for microprocessors, computers, peripheral clocks, watches, instruments and other time management products.

The standard Watch Crystal at 32.768 kHz is available in miniature and sub-miniature packages. Other frequencies from 20 kHz to 163 kHz are available in the subminiature package.

FEATURES
Rugged Cold Weld
Long Term Stability
Low Cost





Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

STANDARD MARKING
NC26 - Date Code
NC38 - F - "Mfg. Location"*
NC26S - F - Frequency (i.e. F163K)*

• NC26/NC38 STANDARD SPECIFICATIONS

		NC26			NC38			
PARAMETERS	**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**VALUE**
Frequency Range			32.768			32.768		kHz
Frequency Tolerance	T_A = 25°C	-20		+20	-20		+20	PPM
Frequency Stability	Parabolic Coefficient			-0.04			-0.04	PPM / $(\Delta°C)^2$
Temperature Range								
Turnover (T_O)		+20	+25	+30	+20	+25	+30	°C
Operating (T_A)		-10		+60	-10		+60	
Storage (T_{STOR})		-20		+70	-20		+70	
Drive Level				1.0			1.0	µW
Load Capacitance (C_L)			12.5			12.5		pF
Shunt Capacitance (C_O)			0.85			0.9		pF
Motional Capacitance (C_1)			2.0			2.1		fF
Capacitance Ratio (C_O) / (C_1)			400			450		
Equivalent Series Resistance (R_S)			30	50		18	35	kΩ
Insulation Resistance	100 V_{DC}	100			100			MΩ
Aging	Ta = 25°C; per year			±3.0			±3.0	PPM

* Date coding available
All specifications subject to change without notice. Rev. 1/30/93

• NC26S STANDARD SPECIFICATIONS

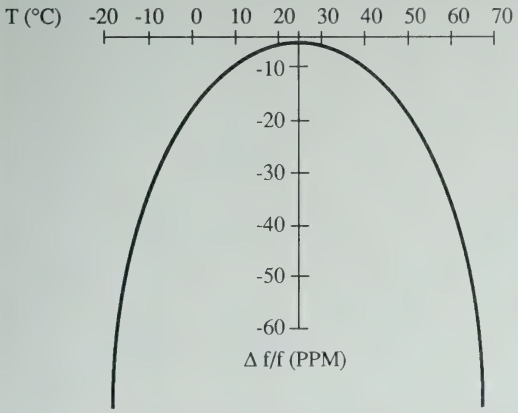
PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Frequency Range		20.000		163.000	kHz
Frequency Tolerance	T_A = 25°C	±15		±100	PPM
Frequency Stability	Parabolic Coefficient			-0.04	PPM / (Δ°C) ^{2}
Temperature Range					
Turnover (T_O)		+15	+25	+35	°C
Operating (T_A)		-10		+60	
Storage (T_{STOR})		-20		+70	
Drive Level				1.0	μW
Load Capacitance (C_L)		3.0	**	15.0	pF
Shunt Capacitance (C_0)		0.6	see graph	1.0	pF
Motional Capacitance (C_1)		0.6	see graph	2.1	fF
Capacitance Ratio (C_0) / (C_1)			400		
Equivalent Series Resistance (R_S)		8.0	see graph	35	kΩ
Insulation Resistance	100 V_{DC}	100			MΩ
Aging	Ta = 25°C; per year			±5.0	PPM

** Varies with frequency.
All specifications subject to change without notice. Rev. 1/30/93

• NC26S STANDARD FREQUENCIES

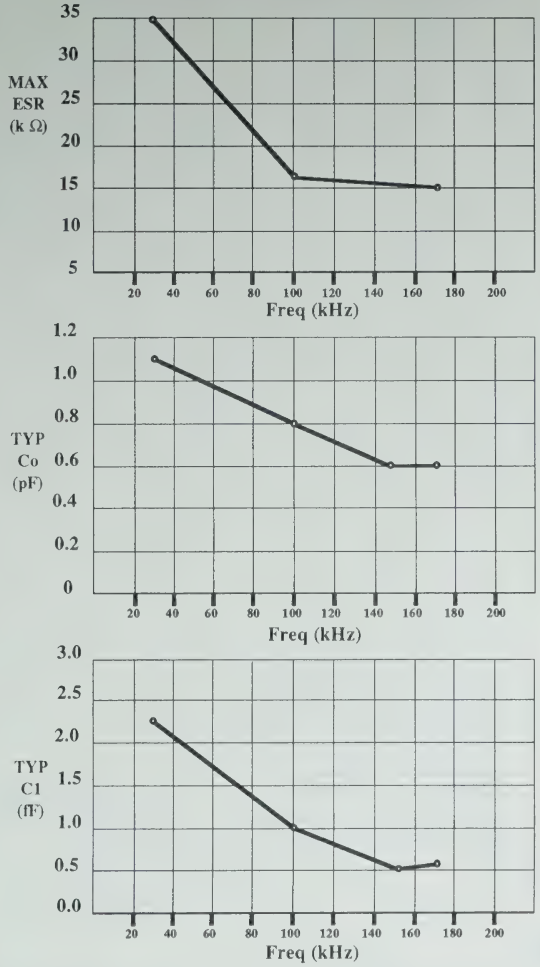
STANDARD FREQUENCIES (kHz)	CL	FREQUENCY TOLERANCE (PPM)
25.600	11 pF	±15PPM
32.768	12.5 pF	±20PPM
36.400	11 pF	±100PPM
40.000	11 pF	±100PPM
40.960	7 pF	±50PPM
64.000	12 pF	±100PPM
65.536	11 pF	±50PPM
76.800	10 pF	±100PPM
77.503	10 pF	±20PPM
100.000	11 pF	±100PPM
120.000	11 pF	±100PPM
128.000	12 pF	±100PPM

PARABOLIC TEMPERATURE CURVE



To determine frequency stability, use parabolic curvature (K).
For example, What is stability at 45°C?
1) Change in T (°C) = 45 - 25 = 20°C
2) Change in frequency = -0.04PPM * $(\Delta T)^2$
= -0.04PPM * $(20)^2$
= -16.0PPM

TYPICAL TUNING FORK PERFORMANCE CHARACTERISTICS

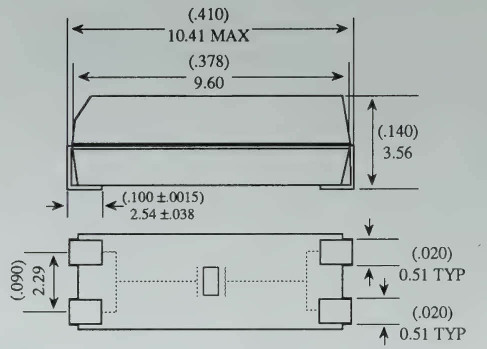


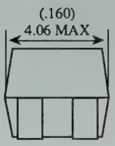
FSM327 / SURFACE MOUNT WATCH CRYSTAL

The FOX FSM327 is a NC26 Watch Crystal encased in a thermoplastic package capable of withstanding 260°C soldering temperatures twice for 10 seconds. This rugged part is perfect for your SMT applications using the 32.768 kHz frequency.

FEATURES

Surface Mountable
Long Term Stability
Small Size





STANDARD MARKING *
FSM327

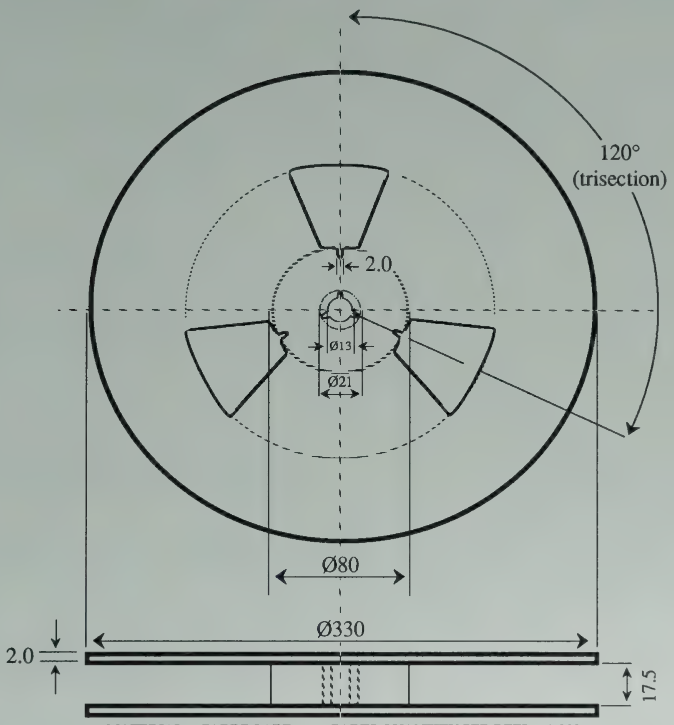
Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

- **FSM327 STANDARD SPECIFICATIONS**

PARAMETERS	CONDITION	MIN	TYP	MAX	VALUE
Nominal Frequency	T_A = 25°C		32.768		kHz
Frequency Tolerance	T_A = 0 ~ +70°C	-20		+20	PPM
Frequency Stability	Parabolic Coefficient			-0.04	PPM / (Δ°C)^2
Temperature Range					
Turnover (T_O)		+20	+25	+30	°C
Operating (T_A)		-40		+85	
Storage (T_{STOR})		-55		+125	
Drive Level				1.0	µW
Load Capacitance (C_L)			12.5 **		pF
Shunt Capacitance (C_O)			0.85		pF
Motional Capacitance (C_1)			2.0		pF
Capacitance Ratio (C_0) / (C_1)			425		
Equivalent Series Resistance (R_S)				50.0	kΩ
Insulation Resistance		100			MΩ
Aging	Ta = 25°C; per year			±3.0	PPM

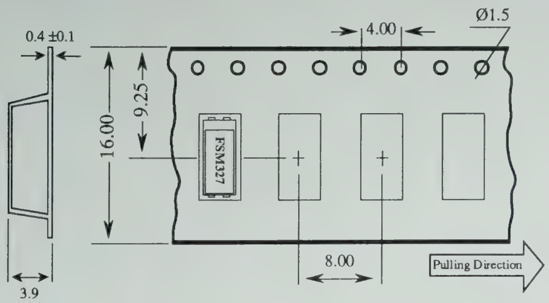
* Date coding available
** Standard - (other load capacitances available)
All specifications subject to change without notice. Rev. 1/30/93

FSM327 REEL DIMENSIONS *

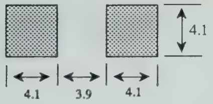


MATERIAL: CARDBOARD PARTS QUANTITY PER REEL: 1,000

FSM327 EMBOSSED CARRIER DIMENSIONS *

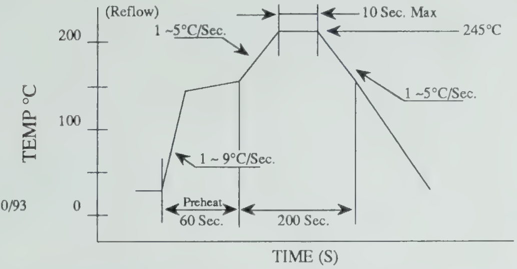


RECOMMENDED SOLDER PAD LAYOUT



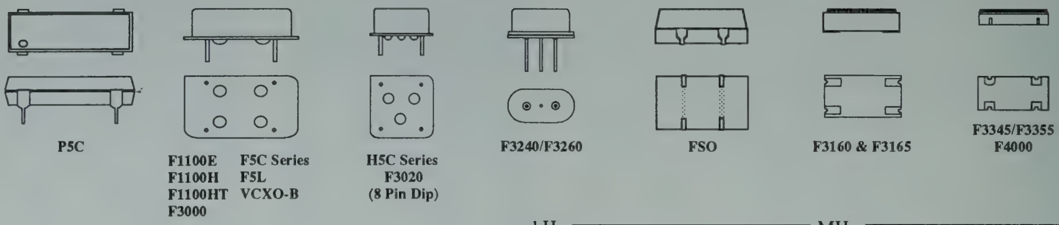
RECOMMENDED SOLDER PROFILE

260°C MAX 10 SEC MAX 2 TIMES OR 230°C MAX, 3 MINUTES, 1 TIME



* Meets EIA-481A-2 and EIAJ-1009B
All dimensions are in millimeters.
All specifications subject to change without notice. Rev. 1/30/93

OSCILLATORS / FREQUENCY RANGES BY PRODUCT TYPE



F1100H -- TTL 14 Pin Metal Package 1.8432 - 80MHz

F1100HT - TTL Tri-State High Frequency
14 Pin metal Package 70 - 110MHz

F1100E -- TTL 14 Pin Metal Package 1 - 100MHz

F3000 -- HCMOS/TTL Tri-State Enable/Disable
14 Pin Metal Package 1.8432 - 110MHz

F3020 -- HCMOS/TTL Tri-State Enable/Disable
Half Size 8 Pin Metal Package 1.8432 - 110MHz

F3240 & F3260 - HCMOS/TTL 1.8432 - 67MHz
3 Pin "AT" Strip - Miniature Size

F3160 & F3165 -- HCMOS/TTL 1.8432 - 100MHz
Surface Mount Ceramic Package

F3345 & F3355 -- HCMOS/TTL 1.8432 - 67MHz
Surface Mount Ceramic Package

F4000 -- 3.3 Volt HCMOS Low Power 1.8432 - 50MHz
Surface Mount Ceramic Package

FSO -- HCMOS & TTL 1.025 - 66.667MHz
Surface Mount Plastic Package

P5C -- HCMOS & TTL 1.025 - 66.667MHz
4 Pin Plastic Packages

H5C -- HCMOS 0.50 - 90MHz
Half Size 8 Pin Metal Package

H5C-2 -- HCMOS/TTL Tri-State '1' Enable/Disable 1.8432 - 70MHz

F5C -- HCMOS 14 Pin Metal Package 4 - 50MHz

F5C-2 -- HCMOS/TTL Tri-State '1' Enable/ Disable 1.8432 - 70MHz
14 Pin Metal Package

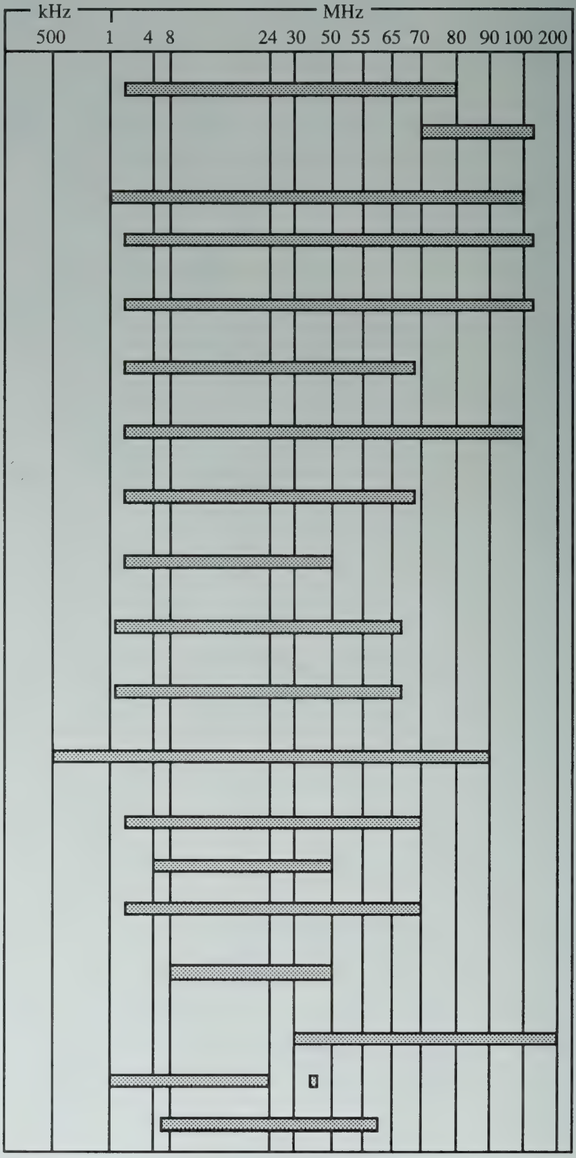
F5C-7 -- HCMOS * Independent Dual Frequency
1: 12 - 32MHz 2: 8.0 - 50MHz 14 Pin Metal Package

F5L -- ECL 14 Pin Metal Package 30 - 200Mhz

VCXO-B 1 - 24MHz & 44.736MHz

TCXO -- Temperature Compensated 5- 60MHz

NEW F6053A / F6151 Programmable Oscillators
.320 ~ 120MHz Call factory for details



* For specific frequency combinations consult customer service.
All specifications subject to change without notice. Rev. 1/30/93

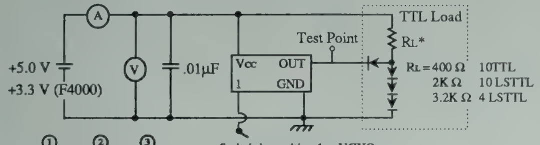
GENERAL OSCILLATOR CHARACTERISTICS

• ENVIRONMENTAL/MECHANICAL SPECIFICATIONS

Rev. 1/30/93

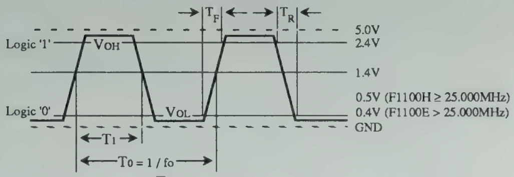
Gross Leak Test	All units 100% leak tested in Fluorinert FC-43
Hermetically Sealed Package	Mass spectrometer leak rate less than 2 x 10^{-8} Atm CC/sec. of Helium
Seal Strength	20 lbs. max. force perpendicular to top and bottom. Subsequently, gross leak tested.
Bend Test (Pin Material)	Will withstand maximum bend of 90°, referenced to base, for 2 bends. Subsequently, gross leak tested. (Iron and Nickel - Nickel coated, solder dipped.)
Solvent Resistance (Marking Ink)	Isopropyl alcohol, Trichloroethane Note 1 - Ultrasonic degreaser not to be used Note 2 - Unit can be cleaned in only one solvent listed (Epoxy, heat cured)
Solderability	The terminals are considered solderable and acceptable for electrical connection if 95 percent of the cooled solder surface is uniform and free from breaks and pinholes. The other 5 percent of the cooled solder surface may show only pinholes, voids, or rough spots that are not concentrated in one area.
Maximum Soldering Temp.	260°C for 10 seconds on leads
Shock Test	1000 G's, 0.35 ms, 1/2 Sine Wave, 3 Shocks each plane
Vibration Test	10-55 Hz, 0.060" D.A., 55-2000 Hz, 20 G's, Duration Time 12 Hrs
Temperature Cycle	5 cycles from -55°C to +125°C, 1 Hr. per cycle, 25°C ref.

TTL TEST CIRCUIT



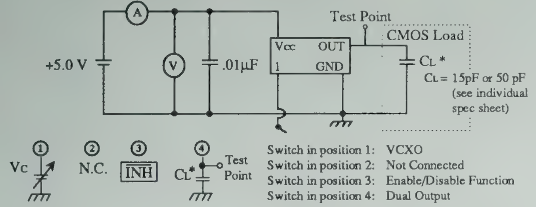
Switch in position 1: VCXO
Switch in position 2: Not Connected
Switch in position 3: Enable/Disable Function
* Includes stray and probe capacitance (15pF TYP)

TTL WAVEFORM



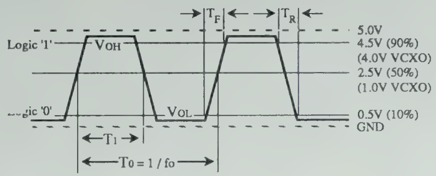
SYMMETRY = $(^{T_1}/_{T_0}) \times 100\%$

HCMOS TEST CIRCUIT



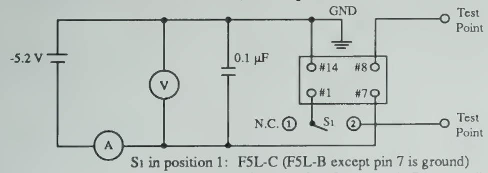
Switch in position 1: VCXO
Switch in position 2: Not Connected
Switch in position 3: Enable/Disable Function
Switch in position 4: Dual Output
* Includes stray and probe capacitance (15pF TYP)

HCMOS WAVEFORM



SYMMETRY = $(^{T_1}/_{T_0}) \times 100\%$

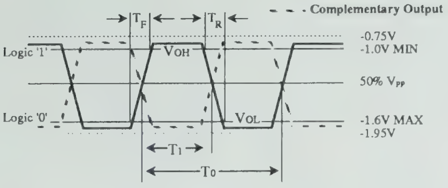
ECL TEST CIRCUIT (with pull down resistors)



S1 in position 1: F5L-C (F5L-B except pin 7 is ground)
S1 in position 2: F5L-4C (F5L-4B except pin 7 is ground)

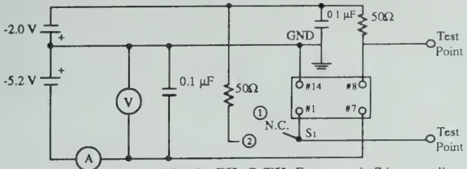
ECL WAVEFORM

(VEE = -5.2V)



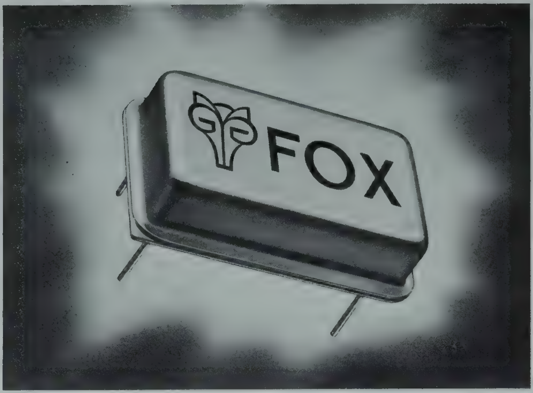
SYMMETRY = $(^{T_1}/_{T_0}) \times 100\%$

ECL TEST CIRCUIT (without pull down resistors)



S1 in position 1: F5L-C (F5L-E except pin 7 is ground)
S1 in position 2: F5L-4C (F5L-4E except pin 7 is ground)

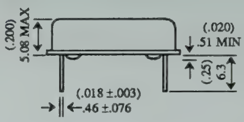
F1100H / TTL CLOCK OSCILLATOR

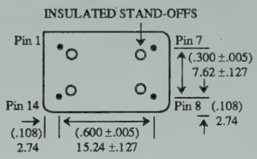


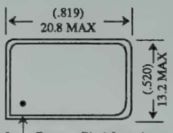
The FOX F1100H Clock Oscillator is TTL Compatible. It has been designed for low current consumption and fast rise times. Its standard 45/55 symmetry allows it to directly drive microprocessors that previously used a divide-by-2 stage in applications up to 50 MHz. The package is all metal with pin 7 as case ground which provides shielding to help minimize EMI radiation.

FEATURES

Low Current Consumption
Fast Rise/Fall Times
45/55 Symmetry up to 50 MHz
Low Noise Emission







Logo Denotes Pin 1 Location

Pin Connections

#1 N.C.	#8 Output
#7 GND (Case)	#14 +5 VDC

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F1100H OPERATING CONDITIONS

Frequency Range		(FO)	1.8432 ~ 80.000	MHz
Temperature Range -	Operating	(TA)	-10 ~ +70	°C
	Storage	(TSTG)	-55 ~ +125	°C
Supply Voltage		(VDD)	5.0 ±0.5	V

• PART NUMBER SELECTION

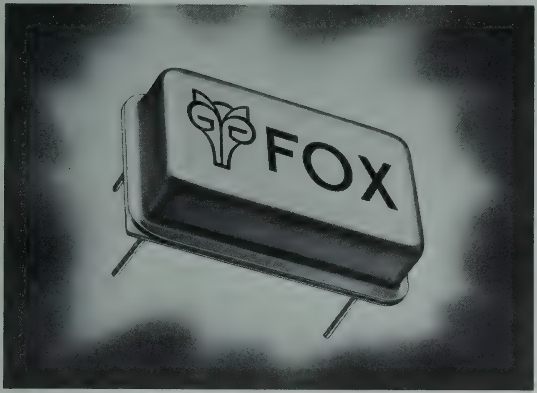
FREQUENCY STABILITY	PART NUMBER
±100PPM (STD)	F1100H
±50PPM	F1145H
±25PPM	F1144H

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V RL = noted below, CL = 15pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	MAX	UNITS
Frequency Stability		All Conditions *	-100	+100	PPM
Input Current (IDD)	1.8432 ~ 4.000	Max Load		7	mA
	4.000+ ~ 20.000			15	
	20.000+ ~ 25.000			17	
	25.000+ ~ 50.000			18	
	50.000+ ~ 80.000			25	
Output Symmetry	1.8432 ~ 50.000	1.4V Level	45	55	%
	50.000+ ~ 80.000		40	60	
Rise Time (TR)	1.8432 ~ 4.000	0.4V to 2.4V		5	ns
	4.000+ ~ 25.000	0.4V to 2.4V		8	
	25.000+ ~ 80.000	0.5V to 2.4V		8	
Fall Time (TF)	1.8432 ~ 25.000	2.4V to 0.4V		5	
	25.000+ ~ 80.000	2.4V to 0.5V		5	
Output Voltage (VOL)	1.8432 ~ 25.000	'0' Logic Level		0.4	V
	25.000+ ~ 80.000			0.5	
(VOH)		'1' Logic Level	2.4		
Output Current (IOL)	1.8432 ~ 25.000	'0' Logic Level	16		mA
	25.000+ ~ 80.000		4		
(IOH)	1.8432 ~ 4.000	'1' Logic Level		-1	
	4.000+ ~ 25.000			-3	
	25.000+ ~ 80.000			-4	
Output Load	1.8432 ~ 25.000	RL = 400Ω		10	TTL
	25.000+ ~ 50.000	RL = 2kΩ		10	LSTTL
	50.000+ ~ 80.000	RL = 2kΩ		8	ASTTL
Start-up Time (TS)	1.8432 ~ 25.000	0.0V to 5.0V		5	ms
	25.000+ ~ 80.000			10	

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

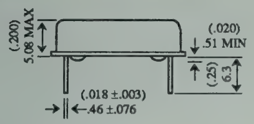
F1100HT / TTL TRI-STATE HIGH FREQUENCY CLOCK OSCILLATOR

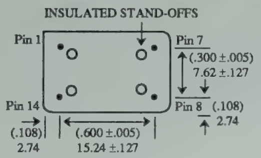


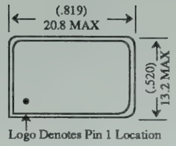
The new FOX F1100HT Clock Oscillator is designed to drive high frequency TTL applications (up to 10-TTL gates). This part has a Tri-State Enable/Disable function on pin 1 to facilitate testing with automatic test equipment (ATE).

FEATURES

High Frequency TTL
Fast Rise/Fall Times
45/55 Symmetry







Pin Connections

#1 E/D **	#8 Output
#7 GND (Case)	#14 +5 V_{DC}

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F1100HT OPERATING CONDITIONS

Frequency Range		(F_O)	70.000 ~ 110.000	MHz
Temperature Range -	Operating	(T_A)	-10 ~ +70	°C
	Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage		(V_{DD})	5.0 ±0.5	V

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM (STD)	F1100HT
±50PPM (to 90MHz)	F1145HT

**** Enable / Disable Function**

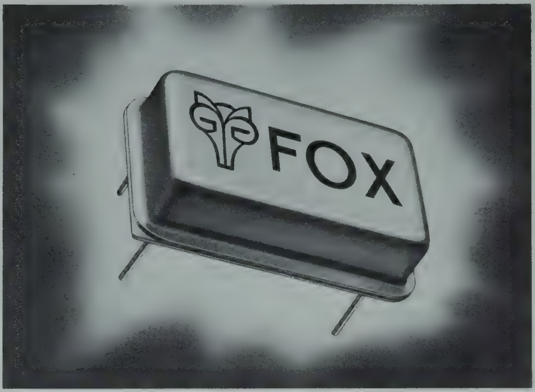
$\overline{INH}$ (Pin 1)	OUTPUT (Pin 8)
OPEN [a]	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• ELECTRICAL CHARACTERISTICS (T$_A$ = 25°C, V$_{DD}$ = 5.0V, R$_L$ = 400 Ω)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	MAX	UNITS
Frequency Stability		All Conditions *	-100	+100	PPM
Input Current (I_{DD})	70.000 ~ 90.000	Max Load		65	mA
	90.000+ ~ 110.00			80	
Output Symmetry		1.4V Level	45	55	%
Rise Time (T_R)		0.5V to 2.4V		3	ns
Fall Time (T_F)		2.4V to 0.5V		3	
Output Voltage (V_{OL})		'0' Logic Level		0.5	V
(V_{OH})		'1' Logic Level	2.4		
Output Current (I_{OL})		'0' Logic Level	16		mA
(I_{OH})		'1' Logic Level		-16	
Output Load		$R_L = 400\Omega$		10	TTL
Start-up Time (T_S)		0.0V to 5.0V		15	ms

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

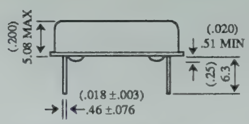
F1100E / TTL CLOCK OSCILLATOR

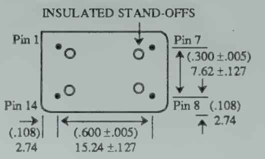


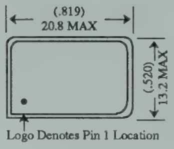
The FOX F1100E Clock Oscillator is TTL Compatible and features fast rise/fall times with high reliability at low cost. The package is all metal with pin 7 as case ground which provides shielding to help minimize EMI radiation.

FEATURES

Rugged Resistance Weld
Drives Full 10 TTL Load
Low Cost







Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

Pin Connections

#1 N.C.	#8 Output
#7 GND (Case)	#14 +5 VDC

• F1100E OPERATING CONDITIONS

Frequency Range		(Fo)	1.000 ~ 100.000	MHz
Temperature Range -	Operating	(TA)	0 ~ +70	°C
	Storage	(TSTG)	-55 ~ +125	°C
Supply Voltage		(VDD)	5.0 ±0.5	V

• PART NUMBER SELECTION

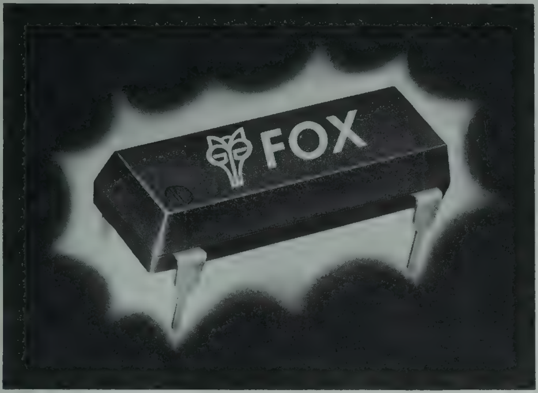
FREQUENCY STABILITY	PART NUMBER
±100PPM (STD)	F1100E
±50PPM	F1145E
±25PPM	F1144E

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V, RL = 400Ω, CL = 15pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	MAX	UNITS
Frequency Stability		All Conditions *	-100	+100	PPM
Input Current (IDD)	1.000 ~ 7.999	Max Load		15	mA
	8.000 ~ 24.999			30	
	25.000 ~ 69.999			70	
	70.000 ~ 100.000			80	
Output Symmetry	1.000 ~ 7.999	1.4V Level	45	55	%
	8.000 ~ 100.000		40	60	
Rise Time (TR)	1.000 ~ 24.999	0.4V to 2.4V		10	ns
	25.000 ~ 69.999	0.5V to 2.4V		6	
	70.000 ~ 100.000	0.5V to 2.4V		4	
Fall Time (TF)	1.000 ~ 24.999	2.4V to 0.4V		10	
	25.000 ~ 69.999	2.4V to 0.5V		6	
	70.000 ~ 100.000	2.4V to 0.5V		4	
Output Voltage (VOL)	1.000 ~ 24.999	'0' Logic Level		0.4	V
	25.000 ~ 100.000			0.5	
(VOH)	All	'1' Logic Level	2.4		
Output Current (IOL)		'0' Logic Level	20		mA
(IOH)		'1' Logic Level		1.0	
Output Load				10	TTL
Start-up Time (Ts)	1.000 ~ 3.499	0.0V to 5.0V		20	ms
	3.500 ~ 3.999			35	
	4.000 ~ 5.999			30	
	6.000 ~ 19.999			20	
	20.000 ~ 100.000			15	

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

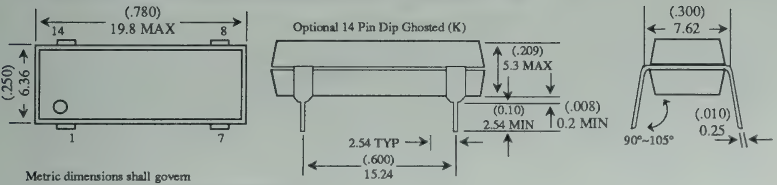
P5C SERIES / HIGH SPEED CMOS / TTL CLOCK OSCILLATOR



The P5C is an all purpose plastic encapsulated oscillator, making it highly reliable and economical. This part drives up to 10 TTL loads, maintains low power consumption, and offers Tri-State Enable/Disable Function.

FEATURES

- Low Profile
- Tri-State Enable Option
- Superior Quality
- TTL or CMOS Compatible
- Drives a Full 10 TTL Loads
- HCMOS Speed
- Low Power Consumption
- Economical Plastic Package
- Standard Pin Configuration
- High Reliability
- Large Manufacturing Capacity



Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• PART NUMBER SELECTION

Pin	P5C, -T, -H	-2, -2T, -2H
1	N.C.	E/D *
7	GND	GND
8	OUT	OUT
14	+5VDC	+5VDC

*** Enable / Disable Function**

$\overline{\text{INH}}$	OUTPUT
OPEN	ACTIVE
'1' Level ($V_{IH} \geq 2.0$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• P5C OPERATING CONDITIONS

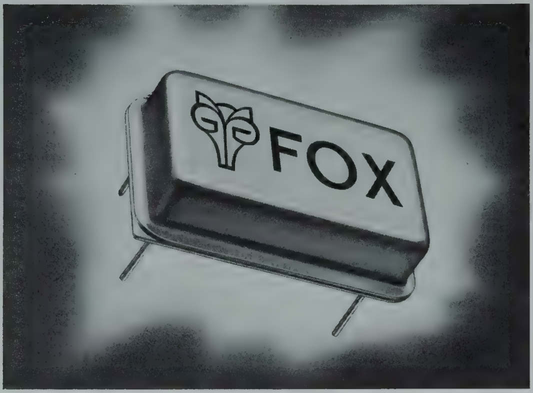
Frequency Range		(F_O)	1.025 ~ 66.667	MHz
Temperature Range -	Operating	(T_A)	-10 ~ +70	°C
	Storage	(T_{STG})	See Table	°C
Supply Voltage		(V_{DD})	5.0 ±0.5	V

• ELECTRICAL CHARACTERISTICS

PARAMETERS	CONDITION	P5C / P5C-2 [1] MIN	P5C / P5C-2 [1] MAX	P5C-T / P5C-2T [1] MIN	P5C-T / P5C-2T [1] MAX	P5C-H / P5C-2H [1] MIN	P5C-H / P5C-2H [1] MAX	UNITS
Frequency Range	----	1.025	26.000	26.000	36.000	(-2H) 26.000	(-2H) 66.667	MHz
						(-H) 30.000	(-H) 55.000	
Frequency Stability **	-10 to +70°C	-100	+100	-100	+100	-100	+100	PPM
Storage Temperature		-55	+125	-55	+100	-55	+100	°C
Input Current (I_{DD})	No Load		25		35		35	mA
	Output Disabled (I_Z)		(-2) 12		(-2T) 20		(-2H) 20	
Output Symmetry	2.5V	40	60	----	----	40	60	%
	1.4V	40	60	40	60	----	----	
Rise Time (T_R)	0.5V ~ 4.5V		8		----		(-2H) 7	ns
	0.4V ~ 2.4V		8		10		(-H) 7	
Fall Time (T_F)	4.5V ~ 0.5V		8		----		(-2H) 7	
	2.4V ~ 0.4V		8		8		(-H) 7	
Output Voltage (V_{OL})	I_{OL} = 16mA		0.4		0.4		0.4	V
(V_{OH})	I_{OH} = -0.4mA	4.5		2.4		4.5		
Output Current (I_{OL})	'0' Logic Level	16		16		4.0		mA
(I_{OH})	'1' Logic Level		-0.4		-0.4		-4.0	
Output Load	TTL		10		10		(-H) 10LS	TTL
	CMOS		50		30		(-2H) 50	pF
Start-up Time (T_S)	0.0V ~ 4.5V		4		10		10	ms
Output Enable/Disable Time	(P5C -2, -2T, -2H)		100		100		100	ns
E/D Input Current (I_{IL})	(Pin 1) $V_{IL} \leq 0.8$V	-100	-15	-100	-15	-100	-15	µA
(I_{IH})	(Pin 1) $V_{IH} > 2.0$V		1.0		1.0		1.0	

** Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
[1] (-2, -2T, -2H) signifies enable/disable function (Pin 1).
All specifications subject to change without notice. Rev. 1/30/93

F5C / HIGH SPEED CMOS OSCILLATOR

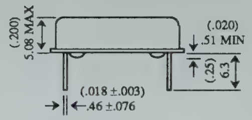


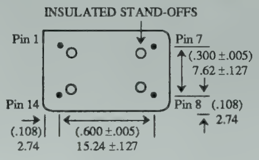
The F5C is a hybrid clock oscillator capable of driving High Speed CMOS circuitry and up to 10 LS-TTL loads. The low current drain makes the part well suited for low power HCMOS applications.

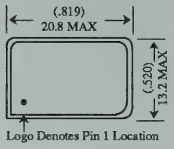
The package is all metal with pin 7 as case ground which provides shielding to help minimize EMI radiation.

FEATURES

Rugged Resistance Weld
Low Power Consumption







Pin Connections

#1 N.C.	#8 Output
#7 GND (Case)	#14 +5 VDC

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F5C OPERATING CONDITIONS

Frequency Range		(FO)	4.000 ~ 50.000	MHz
Temperature Range -	Operating	(TA)	-10 ~ +70	°C
	Storage	(TSTG)	-55 ~ +125	°C
Supply Voltage		(VDD)	5.0 ±0.5	V

• PART NUMBER SELECTION

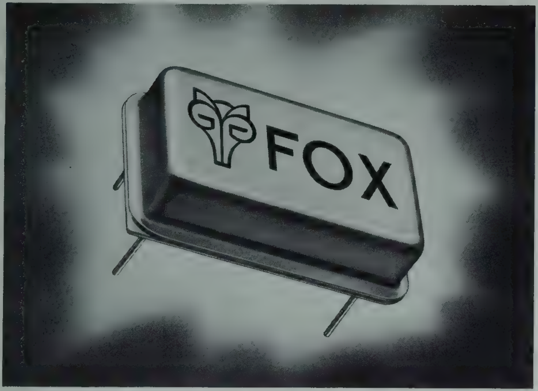
FREQUENCY STABILITY	PART NUMBER
±100PPM	F5C
±50PPM	F6C
±25PPM	F7C (at selected frequencies)

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V , CL = 15pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	MAX	UNITS
Frequency Stability		All Conditions *	-100	+100	PPM
Input Current (IDD)	4.000 ~ 20.000			12	mA
	20.000+ ~ 25.000			15	
	25.000+ ~ 50.000			30	
Output Symmetry		50% VDD Level	45	55	%
Rise Time (TR)	4.000 ~ 25.000	10% ~ 90% VDD Level		10	ns
	25.000+ ~ 50.000			5	
Fall Time (TF)	4.000 ~ 25.000	90% ~ 10% VDD Level		10	
	25.000+ ~ 50.000			5	
Output Voltage (VOL)		'0' Logic Level		0.5	V
(VOH)		'1' Logic Level	4.5		
Output Current (IOL)		'0' Logic Level	4		mA
(IOH)		'1' Logic Level		-4	
Output Load		TTL		10	LSTTL
		HCMOS		15	pF
Start-up Time (TS)	4.000 ~ 25.000			5	ms
	25.000+ ~ 50.000			10	

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

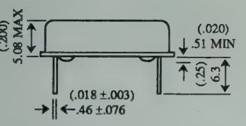
F5C-2 / HCMOS TRI-STATE ENABLE/DISABLE OSCILLATOR

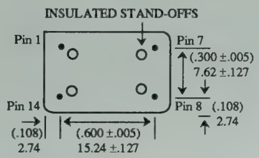


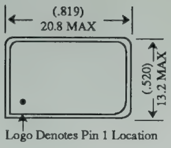
The F5C-2 Clock Oscillator employs a Tri-State buffer for control of the output. Applying a logic '1' voltage level to pin 1 enables the oscillator output and a logic '0' applied to pin 1 disables the output. When disabled, the output goes to the high impedance state. In this state, the oscillator appears to have been removed from the circuit. The high Z state allows the oscillator to be left in the board when testing the board with Automatic Test Equipment.

FEATURES

Tri-State Output allows testing by ATE
10 TTL Fanout
Fast Rise/Fall Time
Tight Symmetry







Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

Pin Connections

#1 E/D **	#8 Output
#7 GND (Case)	#14 +5 VDC

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	F5C-2
±50PPM	F6C-2
±25PPM	F7C-2

**** Enable / Disable Function**

$\overline{\text{INH}}$ (Pin 1)	OUTPUT (Pin 8)
OPEN [a]	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• F5C-2 OPERATING CONDITIONS

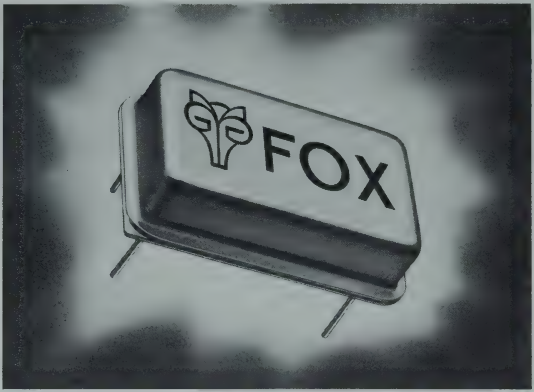
Frequency Range		(F_O)	1.8432 ~ 70.000	MHz
Temperature Range -	Operating	(T_A)	-10 ~ +70	°C
	Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage		(V_{DD})	5.0 ±0.5	V

• ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{DD} = 5.0V , C_L = 15pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		All Conditions *	-100		+100	PPM
Input Current (I_{DD})	1.8432 ~ 25.000				20	mA
	25.000+ ~ 50.000				35	
	50.000+ ~ 70.000				50	
Output Symmetry		50% V_{DD} Level	45	50 ±2	55	%
Rise Time (T_R)		10% ~ 90% V_{DD} Level		1.2 ~ 3.0	7	ns
Fall Time (T_F)		90% ~ 10% V_{DD} Level		0.6 ~ 2.0	7	
Output Voltage (V_{OL})		'0' Logic Level			0.5	V
(V_{OH})		'1' Logic Level	4.5			
Output Current (I_{OL})		'0' Logic Level	16			mA
(I_{OH})		'1' Logic Level			-16	
Output Load		TTL			10	TTL
		HCMOS			15	pF
Start-up Time (T_S)		0.0V to 5.0V			10	ms
Output Enable/Disable Time					100	ns
E/D Input Current (I_{IL})		(Pin 1) $V_{IL} \leq 0.8$V	400			µA
(I_{IH})		(Pin 1) $V_{IH} > 2.2$V			-400	

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
[a] An internal pullup resistor from pin 1 to pin 14 allows active output if pin 1 is left open.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

F3000 / HCMOS/TTL TRI-STATE ENABLE/DISABLE OSCILLATOR

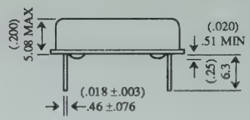


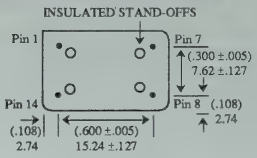
The FOX F3000 Clock Oscillator is our latest design capable of driving the heavy HCMOS loads in applications using the 80386, 80486 & 68030. This oscillator has a Tri-State Enable/Disable on pin 1 to facilitate testing with ATE.

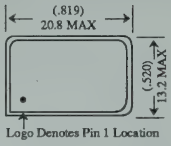
The package is all metal with pin 7 as case ground which provides shielding to help minimize EMI radiation.

FEATURES

Tri-State Enable/Disable
Drives 80386, 80486 & 68030
10 TTL or 50 pF







Pin Connections

#1	E/D **	#8	Output
#7	GND (Case)	#14	+5 V_{DC}

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	F3000
±50PPM	F3005
±25PPM	F3006 (at selected frequencies)

**** Enable / Disable Function**

$\overline{INH}$ (Pin 1)	OUTPUT (Pin 8)
OPEN [a]	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V) ($V_{IH} \geq 2.0$ V above 70 MHz)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• F3000 OPERATING CONDITIONS

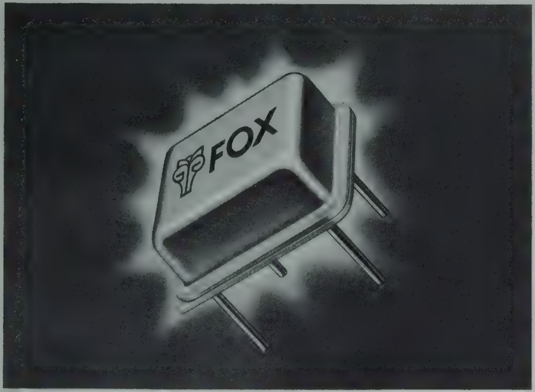
Frequency Range	(F_O)	1.8432 ~ 110.000	MHz
Temperature Range - Operating	(T_A)	-10 ~ +70 0 ~ +70 (60 ~ 110 MHz)	°C
Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage	(V_{DD})	5.0 ±0.5	V

• ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{DD} = 5.0V, C_L = 50pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		All Conditions *	-100		+100	PPM
		T_A = 25°C		±20		
		T_A = -10 ~ +70°C		±40		
		T_A = 0 ~ +70°C (60 ~ 110MHz)				
Input Current (I_{DD})	1.8432 ~ 25.000			17	25	mA
	25.000+ ~ 50.000			33	45	
	50.000+ ~ 70.000			45	70	
	70.000+ ~ 110.000			67	80	
Output Symmetry		50% V_{DD} Level	45	50 ±3	55	%
Rise Time (T_R)	1.8432 ~ 70.000	10% ~ 90% V_{DD} Level			7	ns
	70.000+ ~ 110.000				3	
Fall Time (T_F)	1.8432 ~ 70.000	90% ~ 10% V_{DD} Level			7	
	70.000+ ~ 110.000				3	
Output Voltage (V_{OL})		'0' Logic Level			0.5	V
(V_{OH})		'1' Logic Level	4.5			
Output Current (I_{OL})		'0' Logic Level	16			mA
(I_{OH})		'1' Logic Level			-16	
Output Load		TTL			10	TTL
		HCMOS			50	pF
Start-up Time (T_S)		0.0V to 5.0V			10	ms

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
[a] An internal pullup resistor from pin 1 to pin 14 allows active output if pin 1 is left open.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

F3020 / HALF SIZE HCMOS/TTL TRI-STATE ENABLE/DISABLE OSCILLATOR

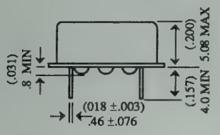


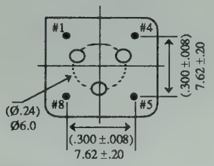
The FOX F3020 Clock Oscillator is our half size design capable of driving the heavy HCMOS loads in applications using the 80386, 80486 & 68030. This oscillator has a Tri-State Enable/Disable on pin 1 to facilitate testing with ATE.

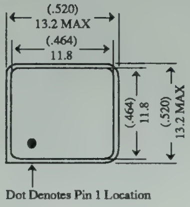
The package is all metal with pin 4 as case ground which provides shielding to help minimize EMI radiation.

FEATURES

Tri-State Enable/Disable
Drives 80386, 80486 & 6803010
TTL or 50 pF







Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

Pin Connections
#1 E/D ** **#5 Output**
# 4 GND (Case) **#8 +5 V$_{DC}$**

• F3020 OPERATING CONDITIONS

Frequency Range	(F$_O$)	1.8432 ~ 110.000	MHz
Temperature Range - Operating	(T$_A$)	-10 ~ +70 0 ~ +70 (60 ~ 110 MHz)	°C
Storage	(T$_{STG}$)	-55 ~ +125	°C
Supply Voltage	(V$_{DD}$)	5.0 ±0.5	V

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	F3020
±50PPM (up to 50 MHz)	F3025

**** Enable / Disable Function**

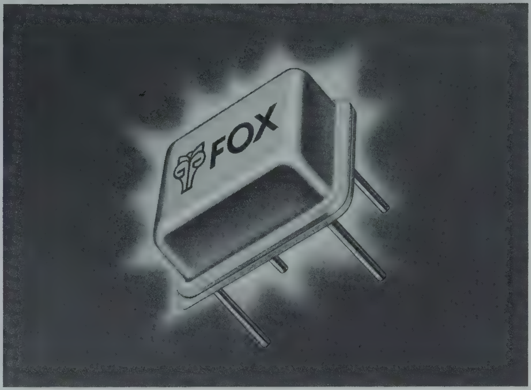
$\overline{\text{INH}}$ (Pin 1)	OUTPUT (Pin 5)
OPEN [a]	ACTIVE
'1' Level (V$_{IH}$ ≥ 2.2 V) (V$_{IH}$ ≥ 2.0 V above 70 MHz)	ACTIVE
'0' Level (V$_{IL}$ ≤ 0.8 V)	High Z

• ELECTRICAL CHARACTERISTICS (T$_A$ = 25°C, V$_{DD}$ = 5.0V, C$_L$ = 50pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		All Conditions *	-100		+100	PPM
		T$_A$ = 25°C		±20		
		T$_A$ = -10 ~ +70°C		±40		
		T$_A$ = 0 ~ +70°C (60 ~ 110MHz)				
Input Current (I$_{DD}$)	1.8432 ~ 25.000			17	25	mA
	25.000+ ~ 50.000			33	45	
	50.000+ ~ 70.000			45	70	
	70.000+ ~ 110.000			67	80	
Output Symmetry		50% V$_{DD}$ Level	45	50 ±3	55	%
Rise Time (T$_R$)	1.8432 ~ 70.000	10% ~ 90% V$_{DD}$ Level			7	ns
	70.000+ ~ 110.000				3	
Fall Time (T$_F$)	1.8432 ~ 70.000	90% ~ 10% V$_{DD}$ Level			7	
	70.000+ ~ 110.000				3	
Output Voltage (V$_{OL}$)		'0' Logic Level			0.5	V
(V$_{OH}$)		'1' Logic Level	4.5			
Output Current (I$_{OL}$)		'0' Logic Level	16			mA
(I$_{OH}$)		'1' Logic Level			-16	
Output Load		TTL			10	TTL
		HCMOS			50	pF
Start-up Time (T$_S$)		0.0V to 5.0V			10	ms

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
[a] An internal pullup resistor from pin 1 to pin 8 allows active output if pin 1 is left open.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

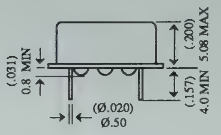
H5C / HALF SIZE HCMOS OSCILLATOR



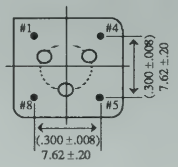
The FOX H5C is a Hybrid Clock Oscillator capable of driving HCMOS circuitry and up to 10 TTL loads. The H5C features low current drain and a smaller footprint than the full size F5C.

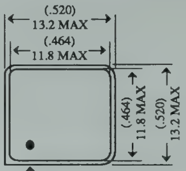
The case-ground metal package minimizes EMI radiation and provides durability with its resistance-weld seal.

FEATURES
Hermetically Sealed Can
Small Footprint
Drives 10-TTL Gates



Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches





Dot Denotes Pin 1 Location

• H5C SPECIFICATIONS

Frequency Range		(Fo)	0.500 ~ 90.000	MHz
Temperature Range -	Operating	(TA)	0 ~ +70	°C
	Storage	(TSTG)	-55 ~ +125	°C
Supply Voltage		(VDD)	5.0 ±0.5	V

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	H5C

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD =5.0V, CL= 15pF)

PARAMETERS	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability	All conditions *	-100		+100	PPM
Input Current	0.500 ~ 30.000 MHz			30	mA
	30.000+ ~ 90.000 MHz			40	
Output Symmetry	50% VDD Level	40		60	%
Rise Time (TR)	10% ~ 90% VDD Level			10	ns
Fall Time (TF)	90% ~ 10% VDD Level			10	
Output Voltage (VOL)	'0' Logic Level			0.5	V
(VOH)	'1' Logic Level	4.5			
Output Current (IOL)	'0' Logic Level	16.0			mA
(IOH)	'1' Logic Level			-0.4	
Output Load	TTL			10	TTL
	HCMOS			15	pF
Start-up Time (TS)	0.0V ~ 5.0V		0.2 ~ 2.5	10	ms

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

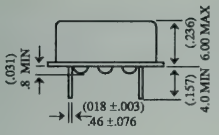
H5C-2 / HALF SIZE HCMOS TRI-STATE ENABLE/DISABLE OSCILLATOR

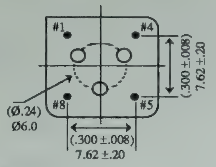
The H5C-2 Clock Oscillator employs a Tri-State function for control of the output. Applying a logic '1' voltage level to pin 1 enables the oscillator output and a logic '0' applied top in 1 disables the output to a high impedance state.

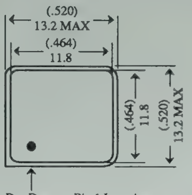
The package is all metal with pin 4 as case ground which provides shielding to help minimize EMI radiation.

FEATURES

Tri-State Output allows testing by ATE
Drives Full 10-TTL Load
Fast Rise/Fall Time







Dot Denotes Pin 1 Location

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

Pin Connections

#1 E/D **	**#5 Output**
# 4 GND (Case)	**#8 +5 V_{DC}**

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	H5C-2
±50PPM	H6C-2
±25PPM (select freqs)	H7C-2

**** Enable / Disable Function**

$\overline{\text{INH}}$ (Pin 1)	OUTPUT (Pin 5)
OPEN [a]	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• H5C-2 OPERATING CONDITIONS

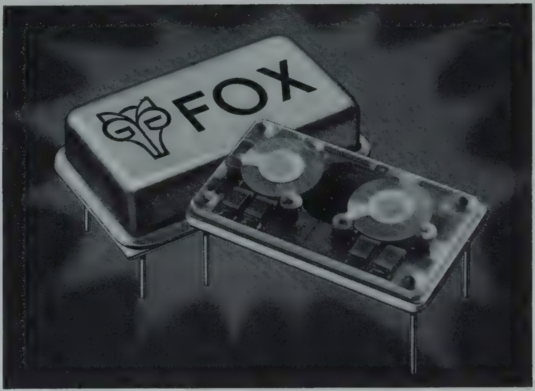
Frequency Range		(F_O)	1.8432 ~ 70.000	MHz
Temperature Range -	Operating	(T_A)	-10 ~ +70	°C
	Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage		(V_{DD})	5.0 ±0.5	V

• ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{DD} = 5.0V , C_L = 15pF)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		All Conditions *	-100		+100	PPM
Input Current (I_{DD})	1.8432 ~ 25.000				20	mA
	25.000+ ~ 50.000				35	
	50.000+ ~ 70.000				50	
Output Symmetry		50% V_{DD} Level	45	50 ±2	55	%
Rise Time (T_R)		10% ~ 90% V_{DD} Level		1.2 ~ 3.0	7	ns
Fall Time (T_F)		90% ~ 10% V_{DD} Level		0.6 ~ 2.0	7	
Output Voltage (V_{OL})		'0' Logic Level			0.5	V
(V_{OH})		'1' Logic Level	4.5			
Output Current (I_{OL})		'0' Logic Level	16			mA
(I_{OH})		'1' Logic Level			-16	
Output Load		TTL			10	TTL
		HCMOS			15	pF
Start-up Time (T_S)		0.0V to 5.0V			10	ms
Output Enable/Disable Time					100	ns
E/D Input Current (I_{IL})		(Pin 1) $V_{IL} \leq 0.8$V	400			µA
(I_{IH})		(Pin 1) $V_{IH} > 2.2$V			-400	

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
[a] An internal pullup resistor from pin 1 to pin 8 allows active output if pin 1 is left open.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

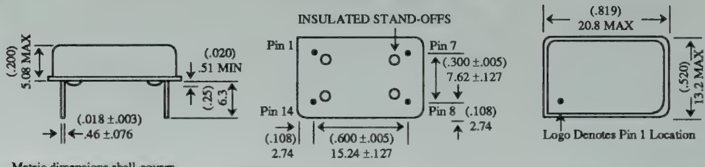
F5C-7 / HCMOS INDEPENDENT DUAL OUTPUT OSCILLATOR



The FOX F5C-7 Independent Dual Output Oscillator employs two crystals to obtain two separate independent frequencies in one package. One motherboard application for the F5C-7 is to drive a CPU and a bus from a single device.

FEATURES

Rugged Resistance Weld
Stainless Steel Cover
Low EMI Performance



Pin Connections
#1 Output 1: F1   #8 Output 2: F2
#7 GND (Case)   #14 +5 VDC

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F5C-7 OPERATING CONDITIONS

Frequency Range			F1: 12.000 ~ 32.000	MHz
			F2: 8.000 ~ 50.000	MHz
Temperature Range -	Operating	(TA)	-10 ~ +70	°C
	Storage	(TSTG)	-55 ~ +125	°C
Supply Voltage		(VDD)	5.0 ±0.5	V

STANDARD FREQUENCY COMBINATIONS	
14.31818/16.000 MHz	16.000/20.000 MHz
14.31818/16.09824 MHz	16.257/16.872 MHz
14.31818/24.000 MHz	25.175/28.321 MHz
14.31818/48.000 MHz	25.175/28.322 MHz

For other frequency combinations please call customer service.

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V, CL = 15pF)

PARAMETERS	FREQUENCY RANGES		CONDITION	MIN	MAX	UNITS
Frequency Stability *			All Conditions	-100	+100	PPM
Input Current (IDD)	F1	F2				
	12.000 ~ 25.000	8.000 ~ 25.000			30	mA
	12.000 ~ 25.000	25.000+ ~ 32.000			40	
	12.000+ ~ 32.000	32.000+ ~ 40.000			50	
Output Symmetry			50% VDD Level	45	55	%
Rise Time (TR)	F1: 12.000 ~ 32.000		0.5V ~ 4.5V		10	ns
	F2: 8.000 ~ 50.000				10	
Fall Time (TF)	F1: 12.000 ~ 32.000		4.5V ~ 0.5V		10	
	F2: 8.000 ~ 32.000				10	
Output Voltage (VOL)			'0' Logic Level		0.5	V
(VOH)			'1' Logic Level	4.5		
Output Current (IOL)			'0' Logic Level	4.0		mA
(IOH)			'1' Logic Level	4.0		
Output Load			TTL		10	LSTTL
			HCMOS		15	pF
Start-up Time (TS)	F1: 12.000 ~ 32.000		0.0V ~ 4.5V		10	ms
	F2: 8.000 ~ 25.000				5	
	25.000 ~ 50.000				10	

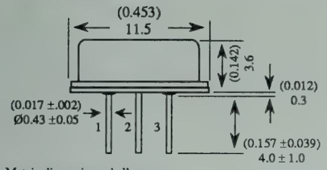
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

F3240 & F3260 / ULTRA SMALL OSCILLATORS

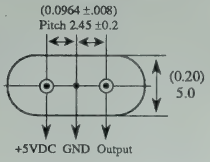
The FOX F3240 & F3260 represent a substantially reduced volume over the 14 pin dip and can drive both HCMOS or TTL loads in applications such as notebook or palmtop computers. The F3240 is designed for driving HCMOS loads of up to 50 pF. The F3260 is designed for applications for smaller loads and features tighter symmetry and lower input current.

FEATURES

Industry Compatible Pinout
Miniature Size



Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches



Pin Connections
#1 +5VDC **#3 Output**
#2 GND (Case)

• F3240 / F3260 OPERATING CONDITIONS

Frequency Range	(Fo)	F3240 1.8432 - 67.000	MHz
		F3260 1.8432 - 50.000	MHz
Temperature Range - Operating	(TA)	-10 to +70	°C
Storage	(TSTG)	-55 to +125	°C
Supply Voltage	(VDD)	5.0 ±0.5	V

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER	
±100PPM (STD)	F3240	F3260
±50PPM	F3245	F3265

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD =5.0V, CL =max load)

PARAMETERS	FREQUENCY RANGES	CONDITION	F3240			F3260			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Frequency Stability		All Conditions *	-100		100	-100		100	PPM
		TA = 25°C		±20			±20		
		TA = -10 to +70°C		±40			±40		
Input Current (IDD)	1.8432 ~ 25.000			17	25		13	20	mA
	25.000+ ~ 50.000	Maximum Load		33	45		25	35	
	50.000+ ~ 67.000			45	60		---	---	
Output Symmetry		50%VDD Level	40	50 ±5	60	45	50 ±3	55	%
Rise Time (TR)		10% ~ 90% VDD Level		4	7		5	10	ns
Fall Time (TF)		90% ~ 10% VDD Level		4	7		5	10	
Output Voltage (VOL)		'0' Logic Level			0.5			0.5	V
(VOH)		'1' Logic Level	4.5			4.5			
Output Current (IOL)		'0' Logic Level	16			4			mA
(IOH)		'1' Logic Level			-16			-4	
Output Load		TTL			10			10 LS	TTL
		HCMOS			50			15	pF
Start-up Time (Ts)		0.0V to 5.0V		3	10		3	10	ms

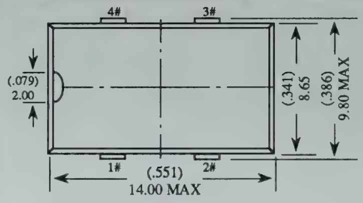
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

FSO / SURFACE MOUNT HCMOS CLOCK OSCILLATORS

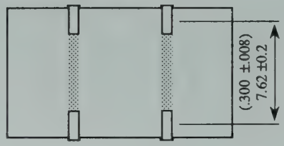
The FOX FSO Series is compatible with both TTL and HCMOS technologies. The J-Leaded configuration and high resistance to soldering temperature make it ideal for surface mount production processes. The FSO offers the low power consumption of HCMOS, but will drive a full 10 TTL Gates when used in a TTL application. This part is built to withstand vapor phase and other high temperature soldering operations and to give long term outstanding performance and reliability.

FEATURES

Extended Temperature Range
Solderable @ 260° for 10 sec.
5000 G Shock Resistance

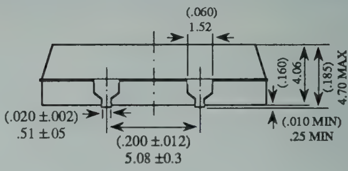


Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches



Pin Connections

#1 E/D or N.C. * **#3 Output**
#2 GND **#4 +5 V_{DC}**



• FSO OPERATING CONDITIONS

Frequency Range		(F_O)	1.025 ~ 66.667	MHz
Temperature Range -	Operating	(T_A)	-40 ~ +85	°C
	Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage		(V_{DD})	5.0 ±0.5	V

*** Enable / Disable Function**

$\overline{\text{INH}}$ (Pin 1)	OUTPUT (Pin 3)
OPEN	ACTIVE
'1' Level ($V_{IH} \geq 2.0$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

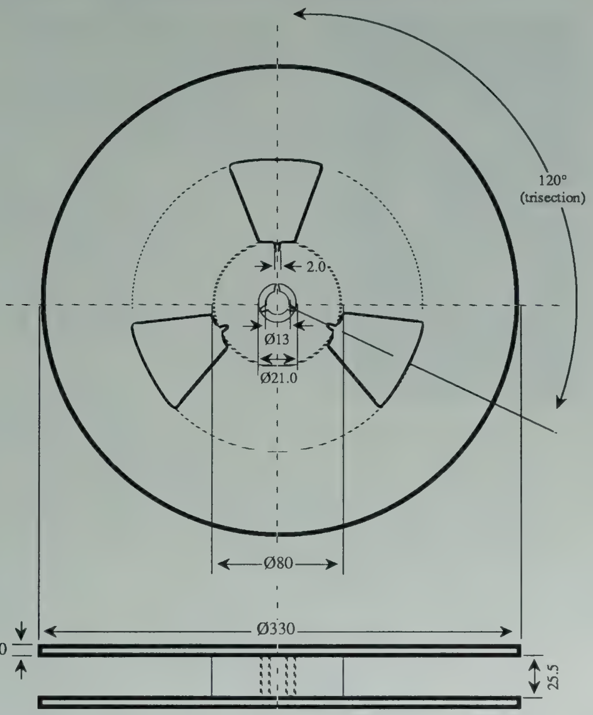
• ELECTRICAL CHARACTERISTICS

[1] (-2. 2T, 2H) signifies enable/disable function (Pin 1).

		FSO / FSO-2 [1]		FSO-T / FSO-2T [1]		FSO-H / FSO-2H [1] ***		
PARAMETERS	**CONDITION**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**UNITS**
Frequency Range		1.025	26.000	26.000	36.000	(-2H) 26.000 (-H) 30.000	(-2H) 66.667 (-H) 55.000	MHz
Frequency Stability **	-10 ~ +70°C	-100	+100	-100	+100	-100	+100	PPM
	-40 ~ +85°C	-200	+200	-200	+200			
Input Current (I_{DD})	No Load		23		35		35	mA
	Output Disabled (I_Z)		(-2) 12		(-2T) 20		(-2H) 20	
Output Symmetry	2.5V	40	60	40	60	40	60	%
	1.4V	40	60	40	60	----	----	
Rise Time (T_R)	0.5V ~ 4.5V		8		10		(-2H) 7	ns
	0.4V ~ 2.4V		8		10		(-H) 7	
Fall Time (T_F)	4.5V ~ 0.5V		8		8		(-2H) 7	
	2.4V ~ 0.4V		8		8		(-H) 7	
Output Voltage (V_{OL})	I_{OL} = MIN		0.4		0.4		(-2H) 0.4	V
(V_{OH})	I_{OH} = MAX	4.5		2.4		4.5		
Output Current (I_{OL})	'0' Logic Level	16		16		4.0		mA
(I_{OH})	'1' Logic Level		-0.4		-0.4		-4.0	
Output Load	TTL		10		10		(-H) 10 LS	TTL
	HCMOS		50		30		(-2H) 50	pF
Start-up Time (T_S)	0.0V ~ 4.5V		4		10		10	ms
Output Enable/Disable Time	-2, -2T, -2H		100		100		100	ns
E/D Input Current (I_{IL})	(Pin 1) $V_{IL} \leq 0.8$V	-100	-15	-100	-15	-100	-15	µA
(I_{IH})	(Pin 1) $V_{IH} > 2.0$V		1.0		1.0		1.0	

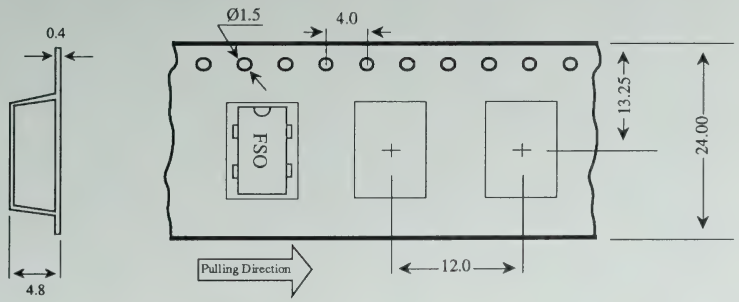
** Inclusive of 25°C tolerance, operating temperature range, input voltage change and load change.
*** Can be utilized in 80386 applications. Consult factory for specifications and availability.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
Note: ±50PPM frequency stability at -10 to +70°C also available.
All specifications subject to change without notice. Rev. 1/30/93

FSO REEL DIMENSIONS *

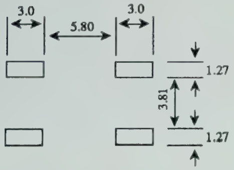


MATERIAL: CONDUCTIVE POLYSTYRENE **PARTS QUANTITY PER REEL: 1,000**

FSO EMBOSSED CARRIER DIMENSIONS *

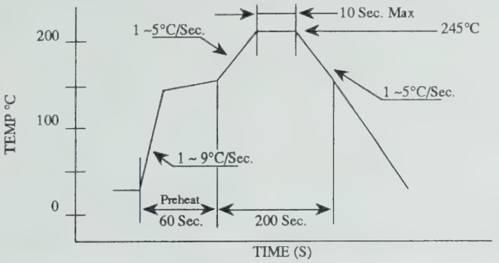


RECOMMENDED SOLDER PAD LAYOUT



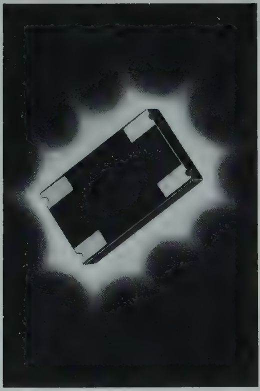
RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



* Meets EIA-481A-2 and EIAJ -1009B
All dimensions in millimeters.
All specifications subject to change without notice. Rev. 1/30/93

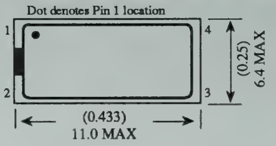
F3160 & F3165 / SURFACE MOUNT OSCILLATORS

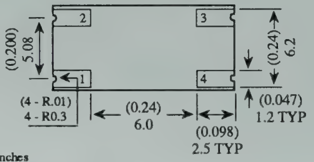


The FOX F3160 & F3165 are ceramic surface mount oscillators which can drive both HCMOS & TTL loads in high density applications such as notebook computers. This oscillator has compatible pin spacing with other industry standards but features smaller overall dimensions.

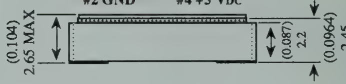
FEATURES

Tri-State Enable/Disable
Drives HCMOS or TTL
Industry Compatible Pinout
Low Noise
F3160 up to 100 MHz





Pin Connections
#1 E/D ** **#3 Output**
#2 GND **#4 +5 V_{DC}**



Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F3160 / F3165 OPERATING CONDITIONS

Frequency Range		(Fo)	F3160	1.8432 - 100.000	MHz
			F3165	1.8432 - 50.000	MHz
Temperature Range -	Operating	(T_A)		-10 to +70	°C
				0 to 70 (60 ~ 100 MHz)	
	Storage	(T_{STG})		-55 to +125	°C
Supply Voltage		(V_{DD})		5.0 ±0.5	V

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER	
±100PPM	F3160	F3165
±50PPM	F3170	F3175
±25PPM	F3171	--------

**** Enable / Disable Function**

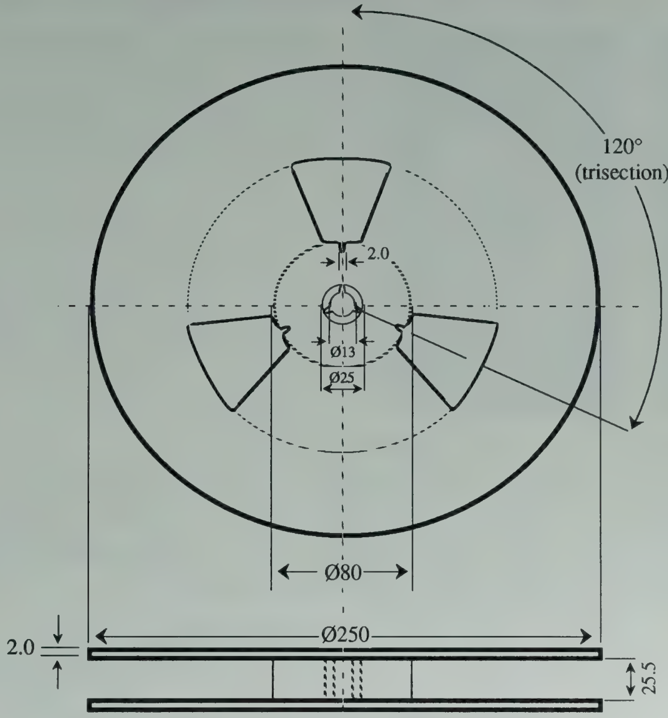
$\overline{\text{INH}}$ (Pin 1)	OUTPUT (Pin 3)
OPEN [a]	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{DD} =5.0V, C_L = Max Load)

PARAMETERS	FREQUENCY RANGES (MHz)	CONDITION	F3160 MIN	F3160 TYP	F3160 MAX	F3165 MIN	F3165 TYP	F3165 MAX	UNITS
Frequency Stability		All Conditions *	-100		100	-100		100	PPM
		T_A = 25°C		±20			±20		
		T_A = -10 to +70°C		±40			±40		
Input Current (I_{DD})	1.8432 ~ 25.000			17	25		13	20	mA
	25.000+ ~ 50.000	Maximum Load		33	45		25	35	
	50.000+ ~ 70.000			45	70		---	---	
	70.000+ ~100.000			67	80		---	---	
Output Symmetry		50% V_{DD} Level	40	50 ±5	60	45	50 ±3	55	%
Rise Time (T_R)	1.8432 ~ 70.000	0.5V to 4.5V		4	7		5	10	ns
	70.000+ ~ 100.000			2	3		---	---	
Fall Time (T_F)	1.8432 ~ 70.000	4.5V to 0.5V		4	7		5	10	
	70.000+ ~ 100.000			2	3		---	---	
Output Voltage (V_{OL})		'0' Logic Level			0.5			0.5	V
(V_{OH})		'1' Logic Level	4.5			4.5			
Output Current (I_{OL})		'0' Logic Level	16			4			mA
(I_{OH})		'1' Logic Level			-16			-4	
Output Load	1.8432 ~ 70.000	TTL			10			10 LS	TTL
	1.8432 ~ 100.000	HCMOS			50			15	pF
Start-up Time (T_S)		0.0V to 5.0V		3	10		3	10	ms
Enable/Disable Time					100			100	ns
$\overline{\text{INH}}$ Input Current (I_{IL})		(Pin 1) $V_{IL} \leq 0.8$V	400	50		400			µA
(I_{IH})		(Pin 1) $V_{IH} \geq 2.2$V		30	-400			-400	

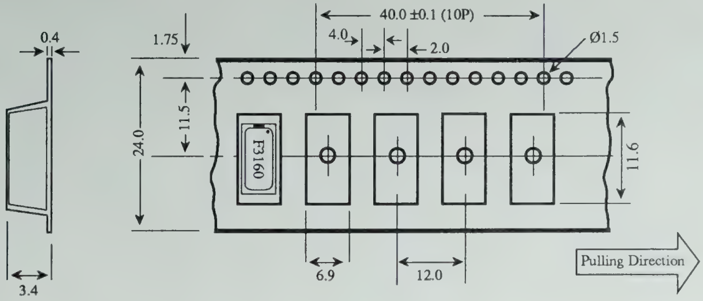
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
[a] An internal pullup resistor from Pin 1 to Pin 4 allows active output if Pin 1 is left open.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

F3160 / F3165 REEL DIMENSIONS *

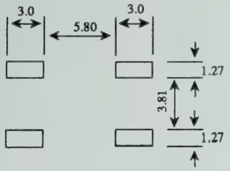


MATERIAL: CONDUCTIVE POLYSTYRENE PARTS QUANTITY PER REEL: 1,000

F3160 / F3165 EMBOSSED CARRIER DIMENSIONS *

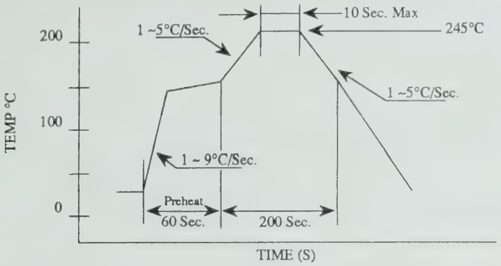


RECOMMENDED SOLDER PAD LAYOUT



RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



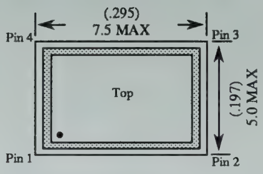
* Meets EIA-481A-2 and EIAJ-1009B
All dimensions in millimeters
All specifications subject to change without notice. Rev. 1/30/93

F3345/F3355 / CERAMIC SMD HCMOS OSCILLATORS

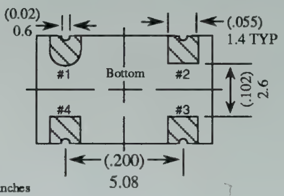
The FOX F3345 / F3355 are our smallest surface mount oscillators, perfect for applications such as miniature computers & peripherals, telecommunication devices and instrumentation. These miniature designs offer high reliability utilizing a hermetically sealed ceramic package.

FEATURES

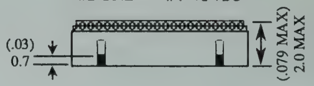
Miniature Profile
High Capacitive Load Option
Tri-State Enable/Disable
Tape & Reel (Standard Qty. 2000+)
Low EMI



Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches



Pin Connections
#1 E/D ** #3 OUTPUT
#2 GND #4 +5V_{DC}



• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER	
±100PPM	F3345	F3355
±50PPM	F3340	F3350

**** Enable / Disable Function**

$\overline{\text{INH}}$ (Pin 1)	OUTPUT (Pin 3)
OPEN [a]	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• F3345 / F3355 OPERATING CONDITIONS

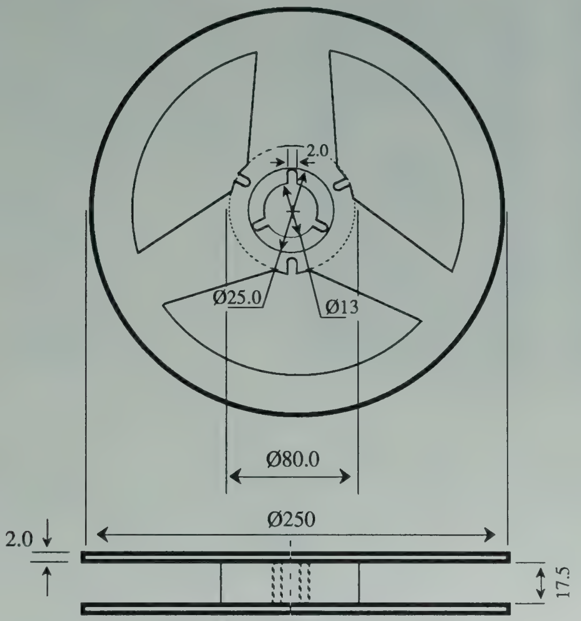
Frequency Range	(F_O)	F3345 1.8432 - 67.000	MHz
		F3355 1.8432 - 50.000	MHz
Temperature Range - Operating	(T_A)	-10 to +70	°C
Storage	(T_{STG})	-55 to +125	°C
Supply Voltage	(V_{DD})	5.0 ±0.5	V

• ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{DD} =5.0V, C_L = Max Load)

PARAMETERS	FREQUENCY RANGES	CONDITION	F3345			F3355			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Frequency Stability		All Conditions *	-100		100	-100		100	PPM
		T_A = 25°C		±20			±20		
		T_A = -10 to +70°C		±40			±40		
Input Current (I_{DD})	1.8432 ~ 25.000			17	25		13	20	mA
	25.000+ ~ 50.000	Maximum Load		33	45		25	35	
	50.000+ ~ 67.000			45	60		---	---	
Output Symmetry		50%V_{DD} Level	45	50 ±2	55	45	50 ±2	55	%
Rise Time (T_R)		10% ~ 90% V_{DD} Level		4	7		5	10	ns
Fall Time (T_F)		90% ~ 10% V_{DD} Level		4	7		5	10	
Output Voltage (V_{OL})		'0' Logic Level			0.5			0.5	V
(V_{OH})		'1' Logic Level	4.5			4.5			
Output Current (I_{OL})		'0' Logic Level	16			4			mA
(I_{OH})		'1' Logic Level			-16			-4	
Output Load		TTL			10			10 LS	TTL
		HCMOS			50			15	pF
Start-up Time (T_S)		0.0V to 5.0V		3	10		3	10	ms
Enable/Disable Time					100			100	ns

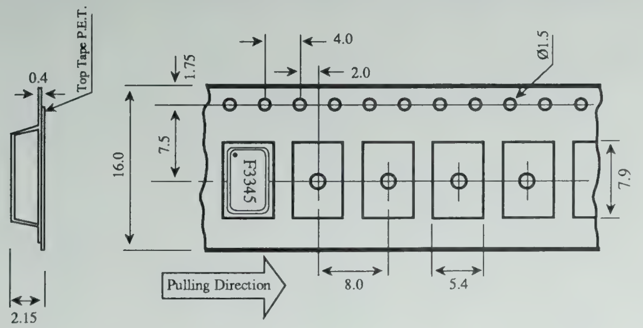
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
[a] An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.
Note: A 0.01 µF bypass capacitor should be placed between V_{DD} (Pin 4) and GND (Pin 2) to minimize power supply line noise.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

F3345 / F3355 REEL DIMENSIONS *

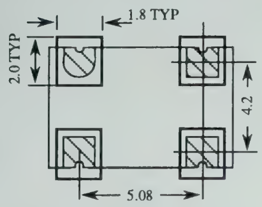


MATERIAL: CONDUCTIVE POLYSTYRENE QUANTITY PER REEL: 2,000 pcs

F3345 / F3355 EMBOSSED CARRIER DIMENSIONS *

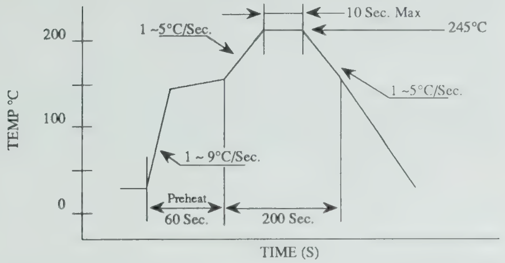


RECOMMENDED SOLDER PAD LAYOUT



RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



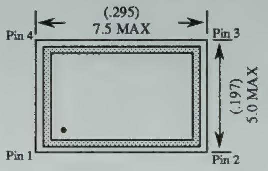
* Meets EIA-481A-2 and EIAJ-1009B
All dimensions in millimeters
All specifications subject to change without notice. Rev. 1/30/93

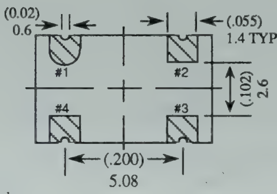
F4000 / MINIATURE CERAMIC SMD 3.3 V OSCILLATOR

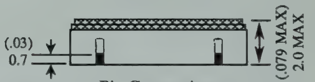
Fox stands on the leading edge of technology with the new 3.3 volt oscillator. Among the many benefits of the F4000 are increased battery life, reduced heat generation and improved EMI. The super small package provides the low profile necessary for today's advanced portable PC and instrumentation designs.

FEATURES

Miniature Profile
Surface Mount
Tape & Reel
Lower Power Consumption
Tri-State Enable/Disable







Pin Connections

#1 E/D **   #3 OUTPUT
#2 GND   #4 3.3VDC

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F4000 OPERATING CONDITIONS

Frequency Range		(F_O)	1.8432 - 50.000 MHz
Temperature Range -	Operating	(T_A)	-10 to +70 °C
	Storage	(T_{STG})	-55 to +125 °C
Supply Voltage		(V_{DD})	3.3 ± 0.3 V

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	F4000

**** Enable / Disable Function**

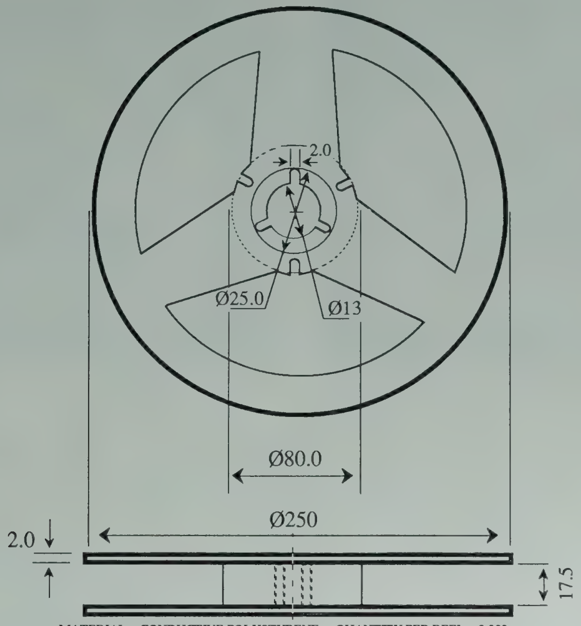
$\overline{INH}$ (Pin 1)	OUTPUT (Pin 3)
OPEN	ACTIVE
'1' Level ($V_{IH} \geq 2.2$ V)	ACTIVE
'0' Level ($V_{IL} \leq 0.8$ V)	High Z

• ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{DD} = 3.3V, C_L= 15pF)

PARAMETERS	FREQUENCY RANGE	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		All conditions *	-100		+100	
		T_A = 25°C		±20		PPM
		T_A = -10 to +70°C		±40		
Input Current (I_{DD})	1.8432 ~ 32.000 MHz			1.5 ~ 8.0	12.0	mA
	32.000+ ~ 50.000 MHz			8.0 ~ 12.0	16.5	
Output Symmetry		50% V_{DD} Level	45	50 ±2	55	%
Rise Time (T_R)		10% V_{DD} ~ 90% V_{DD}		2.5	7	ns
Fall Time (T_F)		90% V_{DD} ~ 10% V_{DD}		1.8	7	
Output Voltage (V_{OL})		'0' Logic Level			10% V_{DD}	V
(V_{OH})		'1' Logic Level	90% V_{DD}			
Output Current (I_{OL})		'0' Logic Level	16.0			mA
(I_{OH})		'1' Logic Level	16.0			
Output Load		HCMOS			15	pF
Output Enable/Disable Time		(See table **)			100	ns
Start-up Time	1.8432 ~ 32.000 MHz			0.8	5	ms
	32.000+ ~ 50.00 MHz			3.0	10	

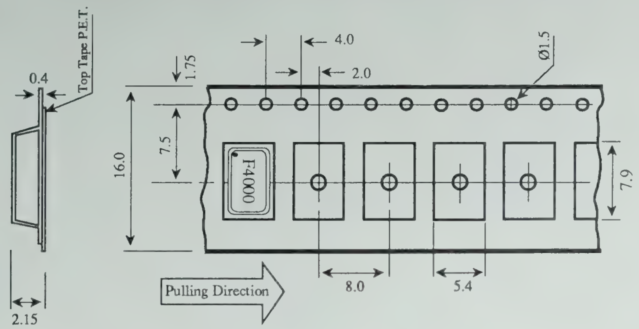
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

F4000 REEL DIMENSIONS *

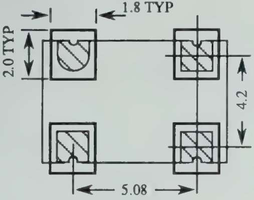


MATERIAL: CONDUCTIVE POLYSTYRENE QUANTITY PER REEL: 2,000 pcs

F4000 EMBOSSED CARRIER DIMENSIONS *

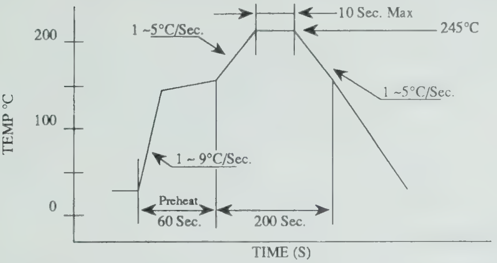


RECOMMENDED SOLDER PAD LAYOUT



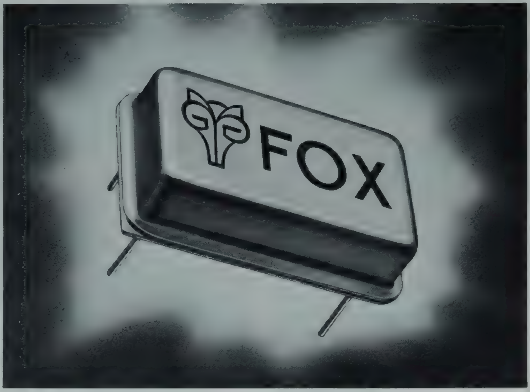
RECOMMENDED SOLDER PROFILE

260°C MAX, 10 SEC MAX, 2 TIMES or 230°C MAX, 180 SEC MAX, 1 TIME



* Meets EIA-481A-2 and EIAJ-1009B
All dimensions in millimeters
All specifications subject to change without notice. Rev. 1/30/93

F5L / 14 PIN DIP ECL OSCILLATOR



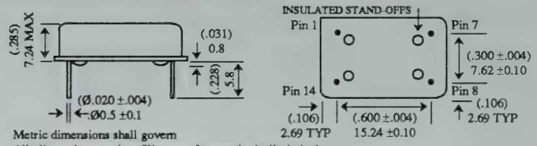
FOX F5L ECL Clock Oscillators feature a high frequency range. The standard 14 pin dip all metal package provides shielding to minimize RF radiation, helping to meet FCC EMI specifications.

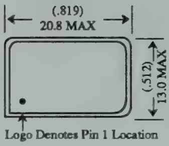
FEATURES

10 KH Logic Output
Low Noise

OPTIONS

Complementary Output
Pullup/Down Internal Resistors
Various Pin Connections





F5L-F Pin Connections
#1 OPEN #8 Output
#7 -5.2 VDC #14 GND (Case)

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• F5L OPERATING CONDITIONS

Frequency Range		(Fo)	30.000 ~ 200.000	MHz
Temperature Range -	Operating	(T_A)	-10 ~ +70	°C
	Storage	(T_{STG})	-55 ~ +125	°C
Supply Voltage		(V_{DD})	-5.2 ±0.26	V **

• PART NUMBER SELECTION

FREQUENCY STABILITY	PART NUMBER
±100PPM	F5L-X
±50PPM	F6L-X
±25PPM	F7L-X

X = see table below

• ELECTRICAL CHARACTERISTICS (T_A = -10 to 70°C V_{EE} = 5.2V ±5%**, V_{TT} = -2.0V** R_T = 50Ω**)

PARAMETERS	FREQUENCY RANGES	CONDITION	MIN	TYP	MAX	UNITS
Frequency Stability		*	-100	±50	+100	PPM
Input Current (I_{DD})	30.000 ~ 170.000			28	40	mA
		(F5L-G, H, 4G, 4H)**		33 ~ 38	50	
	170.000+ ~ 200.000			38	50	
		(F5L-G, H, 4G, 4H)**		43 ~ 48	60	
Output Symmetry		50% V_{P-P} Level	40	50 ±5	60	%
Rise Time (T_R)	30.000 ~ 170.000	20% V_{P-P} ~ 80% V_{P-P}		1.0	2.0	ns
	170.000+ ~ 200.000			0.7	1.5	
Fall Time (T_F)	30.000 ~ 170.000	80% V_{P-P} ~ 20% V_{P-P}		1.0	2.0	
	170.000+ ~ 200.000			0.7	1.5	
Output Voltage (V_{OL})		'0' Logic Level	-1.95		-1.60	V
		(F5L-G, H, 4G, 4H)**	+3.05		+3.42	
(V_{OH})		'1' Logic Level	-1.00		-0.75	
		(F5L-G, H, 4G, 4H)**	+4.00		+4.45	
Output Current (I_{OL})		'0' Logic Level	1.0			mA
(I_{OH})		'1' Logic Level			25.0	
Output Load		ECL Load			5	Gates
Overlap Time (To)		50% V_{P-P} (Complementary only)			0.5	ns
Start-up Time (Ts)					10	ms

Single Output Part#	Pin 1	Pin 7	Pin 8	Pin 14	PullUp/Down Resistor
F5L-B	NC	GND	OUTPUT	-5.2V	Down [a]
E	NC	GND	OUTPUT	-5.2V	None
C	NC	-5.2V	OUTPUT	GND	Down [a]
F	NC	-5.2V	OUTPUT	GND	None
H	NC	GND	OUTPUT	+5.0V	Up [a]
G	NC	GND	OUTPUT	+5.0V	None

[a] up to 110MHz

Complementary Output Part#	Pin 1	Pin 7	Pin 8	Pin 14	PullUp/Down Resistor
F5L-4B	OUTPUT 1	GND	OUTPUT 2	-5.2V	Down [b]
4E	OUTPUT 1	GND	OUTPUT 2	-5.2V	None
4C	OUTPUT 1	-5.2V	OUTPUT 2	GND	Down [b]
4F	OUTPUT 1	-5.2V	OUTPUT 2	GND	None
4H	OUTPUT 1	GND	OUTPUT 2	+5.0V	Up [b]
4G	OUTPUT 1	GND	OUTPUT 2	+5.0V	None

[b] up to 170MHz

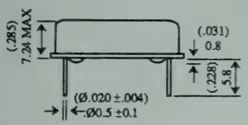
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
** F5L-G, F5L-H Vcc = 5.0V ±0.25V. Consult factory for test circuitry.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

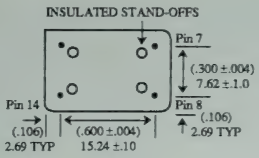
VCXO-B / VOLTAGE CONTROLLED CRYSTAL OSCILLATOR

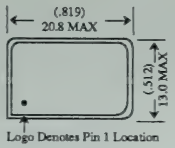
The FOX VCXO-B Series is a tight tolerance, voltage controlled oscillator. The frequency can be altered as much as ±200PPM by applying a voltage between .5V & 4.5V to pin 1. This oscillator is designed especially to be used in phase lock loop applications requiring maximum frequency capture range.

FEATURES

Rugged Resistance Weld
TTL Output
Tight Stability
Low Current Consumption







Pin Connections
#1 Vc #8 Output
#7 GND #14 +5 VDC

Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

FREQUENCY CHARACTERISTICS (PPM)

PART#	STABILITY (MAX) *	PULLABILITY (MIN) Vc = 2.5 ±2V
VCXO-B1	±100	±200
VCXO-B2	±50	±200
VCXO-B3	±50	±100
VCXO-B4	±25	±100
VCXO-B5	±20	±50
VCXO-B6 (44.736MHz)	±50	±100

• VCXO-B SPECIFICATIONS

Frequency Range [a]	(FO)	1.000 ~ 24.000, 44.736	MHz
Temperature Range - Operating	(TA)	-10 ~ +70	°C
Storage	(TSTG)	-30 ~ +85	°C
Supply Voltage	(VDD)	5.0 ± 0.25	V
Control Voltage	(VC)	2.5 ±2.0	V

• ELECTRICAL CHARACTERISTICS (TA = 25°C, VDD = 5.0V, CL= 15pF)

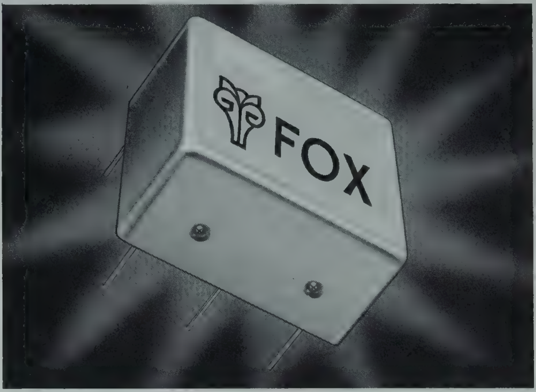
PARAMETERS	CONDITION	MIN	TYP	MAX	UNITS
Input Current (IDD)			7 ~ 10	15	mA
Output Symmetry	50% VDD Level	40	50 ±5	60	%
Rise Time (TR)	20% ~ 80% VDD Level		6	10	ns
Fall Time (TF)	80% ~ 20% VDD Level		6	10	
Output Voltage (VOL)	'0' Logic Level			0.5	V
(VOH)	'1' Logic Level	4.5			
Output Current (IOL)	'0' Logic Level	3.2			mA
(IOH)	'1' Logic Level	0.1			
Output Load	TTL Load			10	LSTTL
	HCMOS Load			15	pF
Start-up Time	0.0V ~ 5.0V			10	ms

• STANDARD FREQUENCIES

1.000 MHz	3.088 MHz	8.192 MHz	12.228 MHz	14.31818 MHz	20.480 MHz
1.544 MHz	4.096 MHz	10.000 MHz	12.352 MHz	16.384 MHz	44.736 MHz
2.048 MHz	6.176 MHz	10.240 MHz	12.800 MHz	20.000 MHz	

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
[a] Custom frequencies will be considered for development.
All specifications subject to change without notice. Rev. 1/30/93

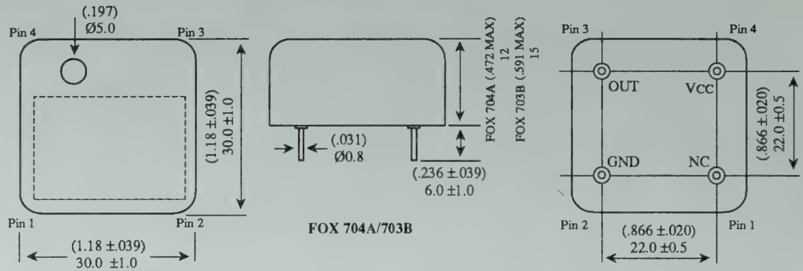
TCXO / TEMPERATURE COMPENSATED OSCILLATOR



FOX Temperature Compensated Crystal Oscillators feature a highly stable output over wide variations in temperature. In addition, each unit contains a frequency adjust trimmer for tailoring to your needs. Applications for FOX TCXOs are in cellular radio, communications equipment, aerospace, and instrumentation.

FEATURES

Tight Stability Over Wide Temperature Range
Adjustable Frequency
Superior Quality
TTL Compatible
Several Package Styles



FOX 704A/703B

Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

* OUTPUT WAVEFORM

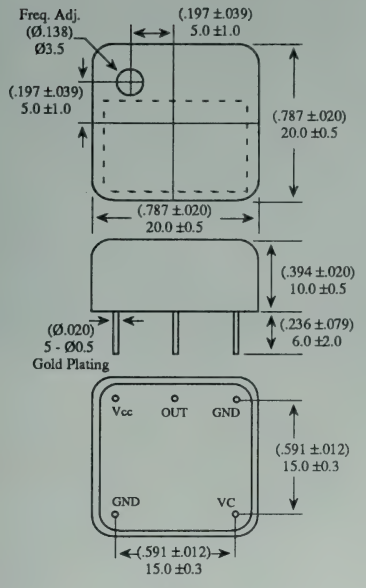
PART#	TYPE
704A	Square
703B	Sine
751A	Clipped Sine
781B	Clipped Sine

• ELECTRICAL CHARACTERISTICS

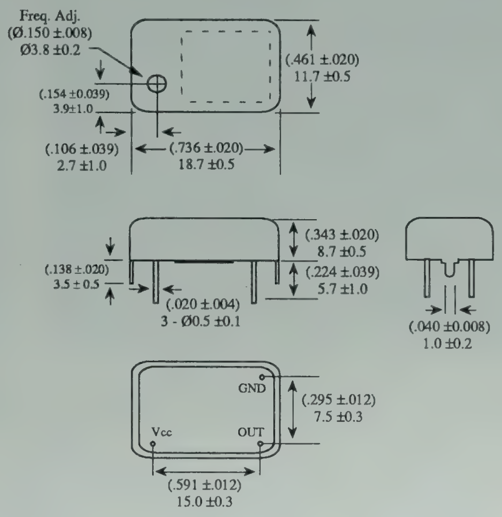
		FOX 704A			FOX 703B			
PARAMETERS	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
Frequency Range		5.000		20.000	8.000		60.000	MHz
Frequency Tolerance	TA = 25°C	-0.5		+0.5	-0.5		+0.5	PPM
Frequency Stability	0°C ~ +50°C	-0.5		+0.5	---	---	---	PPM
	-10°C ~ +60°C	-1.0		+1.0	-1.0		+1.0	
	-20°C ~ +70°C	-1.0		+1.0	---	---	---	
	-30°C ~ +70°C	-1.5		+1.5	---	---	---	
	-20°C ~ +70°C	-2.0		+2.0	---	---	---	
Temperature Range (TA)	Operating	-35		+75	-30		+80	°C
(TSTG)	Storage	-55		+125	-55		+125	
Supply Voltage (VDD)		4.5	5.0	5.5	11.4	12.0	12.6	V
Input Current (IDD)				20			10	mA
Output Voltage (VOL)	(See table *)	0.4						V
(VOH)				2.4				
Output Load	(See table *)			5 LS-TTL		50Ω		
Aging	Per Year @ 25°C	-1.0		+1.0	-1.0		+1.0	PPM
Freq. Stability vs Voltage Change	Δ VDD	-0.3		+0.3	-0.3		+0.3	PPM

Specifications available upon request.
See page 43 for general specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

TCXO / TEMPERATURE COMPENSATED OSCILLATOR



FOX 751A



FOX 781B

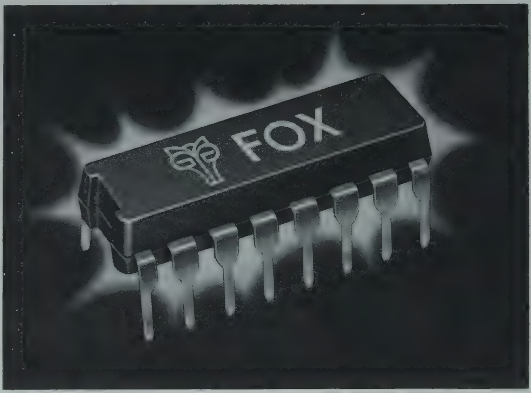
Metric dimensions shall govern
All dimensions are in millimeters & parenthetically in inches

• ELECTRICAL CHARACTERISTICS

PARAMETERS	CONDITION	FOX 751A			FOX 781B			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Frequency Range		10.0		20.0	10.0		20.0	MHz
Frequency Tolerance	TA = 25°C	-0.5		+0.5	-0.5		+0.5	PPM
Frequency Stability	-20°C ~ +70°C	-1.0		+1.0	-2.0		+2.0	PPM
	-30°C ~ +75°C	-1.5		+1.5	-2.5		+2.5	
	-30°C ~ +85°C	-2.5		+2.5	---		---	
Temperature Range	Operating	-35		+85	-35		+85	°C
	Storage	-55		+125	-55		+125	
Supply Voltage		4.7	5.0	5.3	4.7	5.0	5.3	V
Input Current (IDD)				2.5			5	mA
Output Voltage (VOL)	V peak-peak	1.0			1.0			V
Output Load	(See table *)			20			20	kΩ
				5			5	pF
Aging	Per Year @ 25°C	-1.0		+1.0	-1.0		+1.0	PPM
Freq. Stability vs Voltage Change	VDD = 5.0V ±0.3V	-0.5		+0.5	-0.5		+0.5	PPM
Frequency Adjust Range	Vc = 2.5 ±2.0V	5.0			---	---	---	PPM

Specifications available upon request.
See page 43 for environmental/mechanical specifications, test circuits, and output waveforms.
All specifications subject to change without notice. Rev. 1/30/93

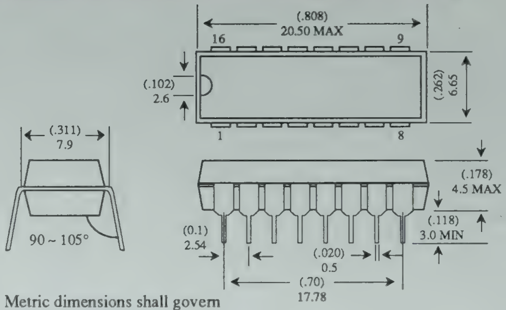
FOX RTC32768 / REAL TIME CLOCK MODULE



The FOX RTC32768 module is a Real Time Clock designed for use with microprocessors. It features a built-in quartz oscillator, time and date functions and an integrated circuit with an available 1Hz output. An external battery can be connected to the RTC as protection against power failures. The built-in 32.768 kHz standard clock quartz oscillator eliminates the need for regulation. Installation is made easy by the 16 pin DIP design.

FEATURES

- Incorporates a built-in time counter (hour, minute, second) and date counter (year, month, date and day of the week).
- 12/24 hour clock switchover function and automatic leap year setting.
- Standard signal output can be set at 1024 Hz, 1 second, 1 minute and 1 hour.
- Counter start, stop and reset functions included.
- The CMOS IC boasts low current consumption and features an external backup function.
- Pin and function are compatible with the MSM58321RS.
- Application notes available.



Metric dimensions shall govern
All dimensions are in millimeters and parenthetically in inches

Pin Connections

1.	CS2	16.	+5 VDC
2.	WRITE	15.	NC
3.	READ	14.	NC
4.	D0	13.	CS1
5.	D1	12.	TEST
6.	D2	11.	STOP
7.	D3	10.	$\overline{\text{BUSY}}$
8.	GND	9.	ADDRESS -WRITE

NC: Do not connect externally

• RTC32768 SPECIFICATIONS

• ABSOLUTE MAXIMUM RATINGS

Item	Conditions	MIN	MAX	UNITS
Power Supply Voltage (V_{DD})	T_A = 25°C	-0.3	7.0	V
Input Voltage ($V_{I/O}$)	T_A = 25°C	GND -0.3V	V_{DD} +0.3V	V
Output Voltage (V_{OL})	T_A = 25°C		0.4	V
(V_{OH})			2.4	
Storage Temperature (T_{STG})		-30	+80	°C

• OPERATING RANGE

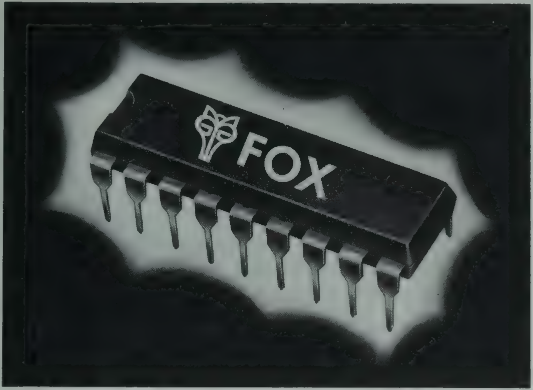
Item	Conditions	MIN	MAX	UNITS
Supply Voltage (V_{DD})		4.5	5.5	V
Input Current (I_{DD})			10	µA
Data Hold Voltage (V_{BAK})		2.0	5.5	V
Operating Temperature (T_A)		-10	+70	°C

• FREQUENCY CHARACTERISTICS

Item	Conditions	MIN	MAX	UNITS
Frequency Tolerance	T_A = 25°C; V_{DD} = 5 V			PPM
RTC 32768A		-10	+10	
RTC 32768B		-50	+50	
Frequency Stability	-10°C ~ +70°C	-120	+10	PPM
Aging (1st yr)	T_A = 25°C; V_{DD} = 5 V		±5.0	PPM

All specifications subject to change without notice. Rev. 1/30/93
Application notes available

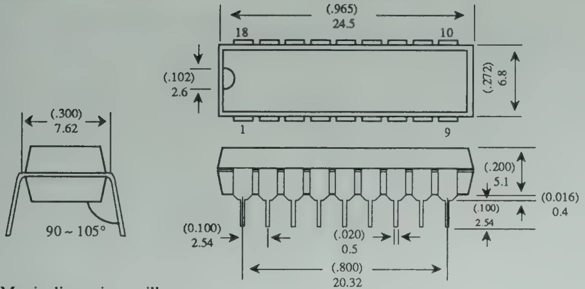
FOX RTC72421 / REAL TIME CLOCK MODULE



The FOX RTC72421 module is a Real Time Clock designed for use with microprocessors. The built-in 32.768 kHz standard clock quartz oscillator eliminates the need for regulation. The RTC72421 uses little or no external hardware (depending on application), and greatly enhances ease of incorporation into circuit designs.

FEATURES

- Built-in quartz crystal
- Time and date functions
- 12/24 hour clock switchover automatic leap year setting
- Faster access time @ 120 nS
- CMOS circuitry
- Lower power consumption than RTC32768
- 18 pin dual in line package
- 4 bit parallel data string
- Application notes available
- Extended temperature range



Metric dimensions will govern.
All dimensions are in millimeters and parenthetically in inches

Pin Connections

1.	STD. P	18.	+5 VDC
2.	CS_0	17.	+5 VDC
3.	ALE	16.	+5 VDC
4.	A_0	15.	CS_1
5.	A_1	14.	D_0
6.	A_2	13.	D_1
7.	A_3	12.	D_2
8.	READ	11.	D_3
9.	GND	10.	WRITE

• RTC72421 SPECIFICATIONS

• ABSOLUTE MAXIMUM RATINGS

Item	Conditions	MIN	MAX	UNITS
Power Supply Voltage (VDD)	TA = 25°C	-0.3	7.0	V
Input Voltage (VI/O)	TA = 25°C	GND -0.3V	VDD +0.3V	V
Output Voltage (VOL)	TA = 25°C		0.4	V
(VOH)			2.4	
Storage Temperature (TSTG)		-55	+85	°C

• OPERATING RANGE

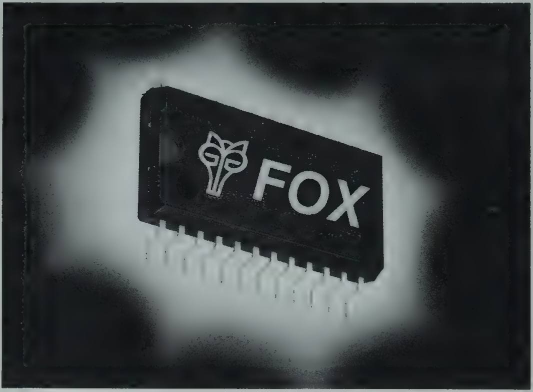
Item	Conditions	MIN	MAX	UNITS
Supply Voltage (VDD)		4.5	5.5	V
Input Current (IDD)			10	µA
Data Hold Voltage (VBAK)		2.0	5.5	V
Operating Temperature (TA)		-40	+85	°C

• FREQUENCY CHARACTERISTICS

Item	Conditions	MIN	MAX	UNITS
Frequency Tolerance	TA = 25°C; VDD = 5 V			PPM
RTC 72421A		-10	+10	
RTC 72421B		-50	+50	
Frequency Stability	-10°C ~ +70°C	-120	+10	PPM
Aging (1st yr)	TA = 25°C; VDD = 5 V		±5.0	PPM

All specifications subject to change without notice. Rev. 1/30/93
Application notes available

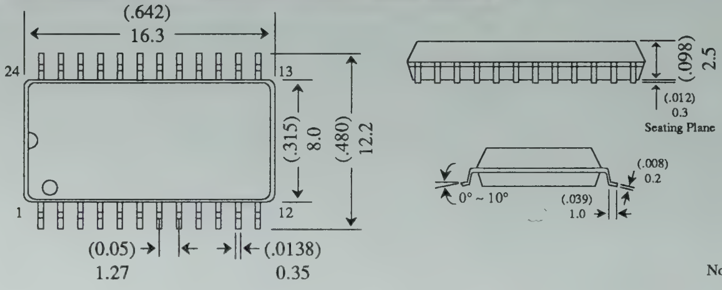
FOX RTC72423 / SURFACE MOUNT REAL TIME CLOCK



The FOX RTC72423 module is the latest design of Real Time Clocks from Fox. It performs the same operations as the RTC72421 but with the additional benefit of being surface mountable.

FEATURES

Surface Mount version of RTC72421
Packed in Auto-insertable tubes
Automatic Leap Year Setting
Low Current Consumption



Pin Connections

1.	STD. P	24.	VDD
2.	CS0	23.	(NC)
3.	NC	22.	(NC)
4.	ALE	21.	NC
5.	A0	20.	CS1
6.	NC	19.	D0
7.	A1	18.	NC
8.	NC	17.	NC
9.	A2	16.	D1
10.	A3	15.	D2
11.	READ	14.	D3
12.	GND	13.	WRITE

Note: (NC) to be at same voltage level as Pin 24

Metric dimensions will govern.
All dimensions are in millimeters and parenthetically in inches

- **RTC72423 SPECIFICATIONS**

• ABSOLUTE MAXIMUM RATINGS

Item	Conditions	MIN	MAX	UNITS
Power Supply Voltage (VDD)	TA = 25°C	-0.3	7.0	V
Input Voltage (VI/O)	TA = 25°C	GND -0.3V	VDD +0.3V	V
Output Voltage (VOL)	TA = 25°C		0.4	V
(VOH)			2.4	
Storage Temperature (TSTG)		-55	+125	°C

• OPERATING RANGE

Item	Conditions	MIN	MAX	UNITS
Supply Voltage (VDD)		4.5	5.5	V
Input Current (IDD)			10	µA
Data Hold Voltage (VHOLD)		2.0	5.5	V
Operating Temperature (TA)		-40	+85	°C

• FREQUENCY CHARACTERISTICS

Item	Conditions	MIN	MAX	UNITS
Frequency Tolerance	TA = 25°C; VDD = 5 V			PPM
RTC 72423A		-20	+20	
RTC 72423B		-50	+50	
Frequency Stability	-10°C ~ +70°C	-120	+10	PPM
Aging (1st yr)	TA = 25°C; VDD = 5 V		±5.0	PPM

All specifications subject to change without notice. Rev. 1/30/93
Application notes available

MONOLITHIC CRYSTAL FILTERS ORDERING GUIDE

This guide was developed to assist you in placing an order for filters with FOX. Each paragraph is numbered to correspond with the numbers on the information required below. **(Copy this sheet and send to Fox when ordering filters.)**

Customer Name ____________________ Date ____________

Address ____

City ____________________ State __________ Zip __________

Telephone (____)______________ Contact ______________

Customer Spec. or Drawing# ______________

1. Holder/Case Size ______________
2. General type: Monolithic Filter ________
   Discrete Filter ________
   Filter Crystal ________
3. Number of Poles ______________
4. Center Frequency ______________
5. Passband Characteristics (dB) ____________
   kHz ____________
6. Stopband Characteristics (dB) ____________
   kHz ____________

Quantity Required ______________

7. Ripple Max (dB) ______________
8. Insertion Loss (dB) ______________
9. Attenuation (dB) ______________
10. Spurious Response (dB) ______________
11. Group Delay Distortion (ms) ______________
12. Terminal Impedance ______________
13. Test Fixture (test circuit) ______________
14. Operating Temp. Range ______________
    __________°C to __________°C
15. Other, if any ______________

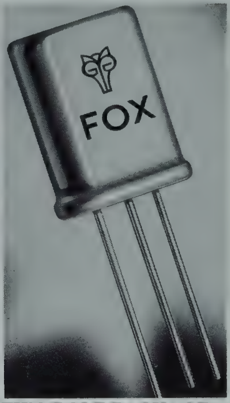
Requirement Schedule ______________

Standard Fox Filters can be ordered from our catalog. Should you require special filters other than those specified on page 73 of this catalog, the above information is required.

1. Please refer to the filter product page for identification of package sizes and dimensions.
2. Check the type you require.
3. Indicate the number of **poles**: 2, 4, 6 or 8. The number of poles determines the passband characteristics.
4. The **center frequency** or nominal frequency is the midpoint in the passband.
5. The **passband** is a frequency range in which the attenuation is guaranteed to be equal to or less than some designated value in dB, typically 3 dB.
6. The **stopband** is that part of the frequency spectrum that is subjected to specified attenuation of signal strength bya filter. (The part of the spectrum between the passband and the stopband is called the transition region.) The power requirement should be provided in decibels and the frequency in kilohertz.
7. The maximum acceptable level of **ripple** should be given in decibels. Ripple is the difference between maximum and minimum attenuation in the passband.
8. **Insertion loss** is the loss in load power due to the insertion of a component or device at some point in a transmission system. (Generally expressed as the ratio in decibels of power received at the load before insertion of the apparatus to the power received at the load after insertion.)
9. **Attenuation** is the maximum guaranteed reduction in power, ranging outside a specified frequency span. Please provide the amount of attenuation in decibels.
10. **Spurious response** attenuation is the minimum acceptable attenuation in the stop band which allows for unwanted modes in the crystal.
11. **Group delay distortion** is the difference between maximum and minimum group delay in the pass band.
12. **Terminating impedance** is the impedance that should be presented to either the source or load side of the filter to ensure proper performance, (usually described by resistance and parallel capacitance).
13. Please provide a schematic of the test circuit.
14. **Operating temperature range** should be provided in centigrade (example: -20°C to +50°C).
15. It is always important to provide as much information as possible about the piece of equipment in which the filter is being used. Please include any additional specifications or background you have available.

MONOLITHIC CRYSTAL FILTERS

MULTI-POLE PACKAGE



TWO POLE PACKAGE

FOX filters offer excellent features such as sharp cut off characteristic, low loss and high stability over wide temperature range which are superior to LC Filters and Ceramic Filters.

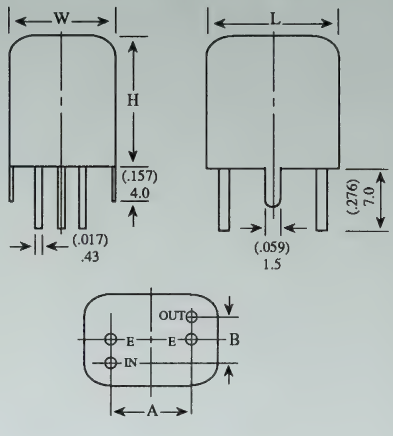
The basic building block for all custom built Fox filters is the two-pole monolithic filter available in standard package as shown. Two-pole monolithic filters are cascaded to produce four, six and eight or more pole filter responses with the addition of coupling capacitors between two-pole sections.

Standard Fox filters are available with center frequencies from 10.7 MHz to 90 MHz, and from two to eight poles.

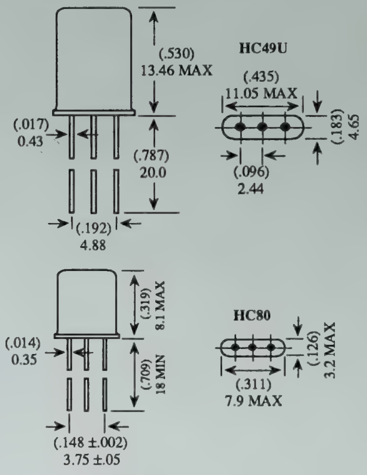
For custom made filters, please specify the following:

- *Holder Size*
- *Nominal Frequency*
- *Pass Bandwidth*
- *Insertion Loss*
- *Attenuation*
- *Spurious Response*
- *Ripple*
- *Impedance*
- *Operating Temp. Range*

Note: 45F Series 45.000 MHz fundamental is a special Filter designed for Mobile Radio and Cellular Phone applications.



MULTI-POLE



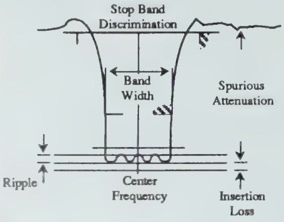
TWO-POLE

MULTI-POLE PACKAGE DIMENSIONS

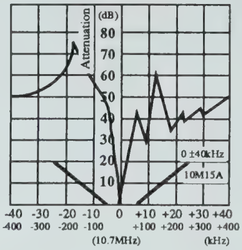
CASE TYPE	L	W	H	A	B
B,C	15.0 (.590)	12.0 (.472)	15.0 (.591)	9.0 (.354)	5.0 (.197)
D	18.5 (.728)	12.0 (.472)	15.0 (.591)	13.5 (.531)	5.0 (.197)
BN, CN	11.0 (.433)	8.5 (.335)	11.5 (.453)	7.4 (.291)	4.0 (.157)
DN	13.4 (.528)	8.5 (.335)	11.5 (.453)	9.8 (.386)	4.0 (.157)

Metric dimensions will govern.
All dimensions are in millimeters and parenthetically in inches
All specifications subject to change without notice. Rev. 1/30/93

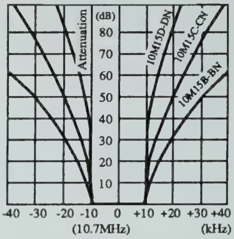
FILTER PARAMETERS



10.7MHz TWO POLE CHARACTERISTICS



MULTI-POLE CHARACTERISTICS



MONOLITHIC CRYSTAL FILTER STANDARD FREQUENCIES

Type	Frequency MHz	Pole	Case	Pass Band		Stop Band				Ripple Max dB	Loss Max dB	Attenuation Guaranteed		Terminating Impedance ohms/pF
				dB	kHz	dB	kHz	dB	kHz			dB	to ±kHz	
10M7A	10.700	2	49U	3	±3.75	20	±18			0.5	1.5	35 40	+300~+1000 - 200~- 1000	1.8K//6.0
10M7B	10.700	4	49Ux 2	3	±3.75	40	±14			1.0	2.5	50 70	+300~+1000 - 200~- 1000	18K//5.0 Cc = 11pF
10M7C	10.700	6	C	3	±3.75	45	±8.75	65	±12.5	2.0	3.5	65	±12.5~±300	1.8K//5.0
10M7D	10.700	8	D	3	±3.75	65	±8.75	90	±12.5	2.0	4.0	90	±12.5~±300	1.8K//5.0
10M12A	10.700	2	49U	3	±6.0	20	±25			0.5	1.5	35 40	+300~+1000 - 200~- 1000	3.3K//1.5
10M12B	10.700	4	49Ux 2	3	±6.0	40	±20			1.0	2.5	50 70	+300~+1000 - 200~- 1000	3.3K//1.5 Cc = 6pF
10M12C	10.700	6	C	3	±6.0	50	±14	65	±20.0	2.0	3.0	65	±20~±300	3.3K//2.0
10M12D	10.700	8	D	6	±6.0	65	±14	90	±20.0	2.0	3.5	90	±20~±300	3.3K//2.0
10M15A	10.700	2	49U	3	±7.5	18	±25			0.5	1.5	35 40	+300~+1000 - 200~- 1000	3.0K//2.0
10M15B	10.700	4	49Ux 2	3	±7.5	40	±25			1.0	2.5	50 70	+300~+1000 - 200~- 1000	3.0K//2.0 Cc = 5pF
10M15C	10.700	6	C	3	±7.5	50	±17.5	65	±25.0	2.0	3.0	65	±25~±300	3.3K//1.5
10M15D	10.700	8	D	6	±7.5	65	±17.5	90	±25.0	2.0	3.5	90	±25~±300	3.3K//1.5
10M20A	10.700	2	49U	3	±10.0	18	±34			0.5	1.5	35 40	+300~+1000 - 200~- 1000	3.9K//1.0
10M20B	10.700	4	49Ux 2	3	±10.0	40	±34			1.0	2.5	50 70	+300~+1000 - 200~- 1000	3.9K//1.0 Cc = 3pF
16M15A	16.900	2	49U	3	±7.5	18	±25			0.5	1.5	35 40	+300~+1000 - 200~- 1000	1.8K//2.0
16M15B	16.900	4	49Ux 2	3	±7.5	40	±25			1.0	2.5	50 70	+300~+1000 - 200~- 1000	1.8K//1.5 Cc = 7.5pF
16M15C	16.900	6	C	3	±7.5	45	±17.5	65	±25.0	2.0	3.0	65	±25~±300	1.8K//1.5
16M15D	16.900	8	D	3	±7.5	65	±17.5	90	±25.0	2.0	3.5	90	±25~±300	1.8K//1.5
21M7A	21.400	2	HC80	3	±3.75	20	±18			0.5	1.5	35 50	+350~+1000 - 200~- 1000	850//6
21M7B	21.400	4	HC80x 2	3	±3.75	40	±14			1.0	2.5	65 80	+350~+1000 - 200~- 1000	850//5 Cc = 16pF
21M7C	21.400	6	CN	3	±3.75	45	±8.75	65	±12.5	2.0	3.0	65	±12.5~±300	850//5
21M7D	21.400	8	CN	3	±3.75	65	±9.0	90	±12.5	2.0	4.0	90	±12.5~±300	850//5
21M12A	21.400	2	HC80	3	±6.0	20	±25			0.5	1.5	35 50	+350~+1000 - 200~- 1000	1.2K//3.0
21M12B	21.400	4	HC80x 2	3	±6.0	40	±20			1.0	2.5	65 80	+350~+1000 - 200~- 1000	1.2K//2.5 Cc = 10.5pF
21M12C	21.400	6	CN	3	±6.0	45	±14	65	±20	2.0	2.5	65	±20~±300	1.2K//2.5
21M12D	21.400	8	CN	3	±6.0	65	±14	90	±20	2.0	3.0	90	±20~±300	1.2K//2.5
21M15A	21.400	2	HC80	3	±7.5	18	±25			0.5	1.5	35 50	+350~+1000 - 200~- 1000	1.5K//2.0
21M15B	21.400	4	HC80x 2	3	±7.5	40	±25			1.0	2.5	65 80	+350~+1000 - 200~- 1000	1.5K//2.0 Cc = 8pF
21M15C	21.400	6	CN	3	±7.5	45	±17.5	65	±25	2.0	2.5	65	±25~±300	1.5K//2.0
21M15D	21.400	8	CN	3	±7.5	65	±17.5	90	±25	2.0	3.0	90	±25~±300	1.5K//2.0
21M20A	21.400	2	HC80	3	±10.0	18	±34			0.5	2.0	35 50	+350~+1000 - 200~- 1000	1.8K//1.5
21M20B	21.400	4	HC80x 2	3	±10.0	40	±34			1.0	2.5	65 80	+350~+1000 - 200~- 1000	1.8K//1.5 Cc = 5pF
21M30A	21.400	2	HC80	3	±15.0	15	±45			0.5	1.5	35 50	+350~+1000 - 300~- 1000	3.0K//0.5
21M30B	21.400	4	HC80x 2	3	±15.0	40	±50			1.0	2.5	65 80	+350~+1000 - 300~- 1000	3K//-0.5 Cc = 3pF
45F15A	45.000	2	HC80	3	±7.5	15	±25			1.0	2.0	35 40	+500~+1000 - 200~- 1000	650//4.5
45F15B	45.000	4	HC80x 2	3	±7.5	30	±25			1.0	3.0	70	+500~+1000 - 200~- 1000	650//1.5 Cc = 9pF
45F20A	45.000	2	HC80	3	±10.0	15	±34			1.0	2.0	35 40	+500~+1000 - 200~-1000	700//2.5
45F20B	45.000	4	HC80x 2	3	±10.0	40	±48			1.0	3.0	70	+500~+1000 - 200~- 1000	700//1.5 Cc = 6.5pF
45F30A	45.000	2	HC80	3	±15.0	15	±50			1.0	2.0	35	+500~+1000 - 300~- 1000	800//1.5
45F30B	45.000	4	HC80x 2	3	±15.0	40	±60			1.0	3.0	70	+500~+1000 - 300~- 1000	800//1.0 Cc = 5pF
45M15A	45.000	2	HC80	3	±7.5	18	±28			1.0	2.0	35	+500~+1000 - 200~- 1000	4K//-1
45M15B	45.000	4	HC80x 2	3	±7.5	40	±30			1.0	3.0	70	+500~+ 1000 - 200~- 1000	4K//-1 Cc= -1pF
45M20A	45.000	2	HC80	3	±10.0	15	±30			1.0	2.0	35	+500~+1000 - 200~- 1000	5K//-1
45M20B	45.000	4	HC80x 2	3	±10.0	35	±40			1.0	3.0	70	+500~+1000 - 200~- 1000	5K//-1.0 Cc = -1.5pF
70M15A	70.000	2	HC80	3	±7.5	15	±30			1.0	2.0	35	+500~+1000 - 200~- 1000	2.5K//-1.0
70M15B	70.000	4	HC80x 2	3	±7.5	25	±25			1.0	3.0	70	+500~+1000 - 200~- 1000	2.0K//-1.0 Cc = -1pF
70M20A	70.000	2	HC80	3	±10.0	15	±40			1.0	2.0	35	+500~+1000 - 200~- 1000	2.5K//-1.0
70M20B	70.000	4	HC80x 2	3	±10.0	35	±40			1.0	3.0	70	+500~+1000 - 200~- 1000	2.5K//-1.0 Cc = -1pF

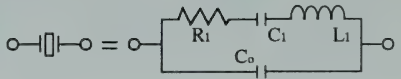
All specifications subject to change without notice. Rev. 1/30/93 Note: Operating Temperature -20°C to +70°C

ENGINEERING DEFINITIONS AND DESIGN NOTES

Theory of Operation

Crystal resonators derive their basic frequency selective capability from a mechanical vibration resulting from a piezoelectric effect in the material. Although the theoretical analysis of this piezoelectric effect is a relatively complex electro-mechanical function, it can be shown as a simple equivalent circuit. (See Figure 1)

Figure 1
Equivalent Crystal Circuit



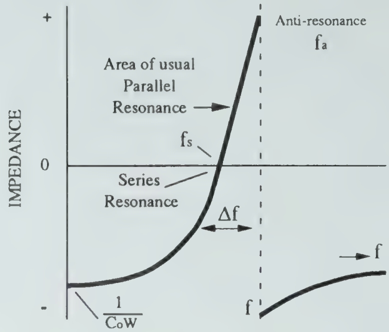
Equivalent Crystal Circuit

The equivalent crystal circuit is useful in explaining the electrical characteristics of a crystal operating near its fundamental resonant frequency. The (Co) static capacitance, is the capacitance measured from pin to pin which includes the crystal electrode, mounting structure and holder. R_1, C_1, and L_1 are known as the motional arm of the circuit. C_1 represents the motional capacitance of the quartz; L_1 is the motional inductance, a function of the mass; and R_1 represents the equivalent motional arm resistance. (See Figure 1)

Quality Factor (Q)

The "Q" of a crystal unit is the Quality Factor of the motional arm at resonance. The maximum stability that can be attained by the crystal is directly related to Q. The higher the Q the smaller the band width (Δf) and the steeper the reactance slope (f_s-f_a). External circuit reactance value changes have less effect on a high Q crystal (less pullability) than lower Q devices. (See Figure 2)

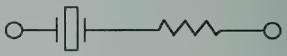
Figure 2
Impedance-Reactance



Series Resonance

When a crystal is operating at series resonance (f_s), it looks resistive in the circuit. Thus, its impedance at f_s is near zero. In a well designed series resonant circuit, correlation is not a problem and load capacitance does not have to be specified.

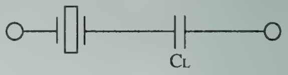
Figure 3
Series Resonance



Parallel Resonance (Anti-resonance)

When a crystal is operating at parallel resonance (f_a), it will look inductive in the circuit. The crystal's impedance reaches its peak at f_a. A change in circuit reactance values will have the effect of pulling the frequency of the crystal. If the crystal is to be used at parallel resonance, the load capacity should always be specified. Load capacity is the dynamic capacity of the total circuit measured or computed across the crystal terminals. In parallel circuit design, the load capacity should be selected to operate the crystal at a stable point on the f_s-f_a reactance curve (as close to f_s as possible).

Figure 4
Anti-Resonance/Parallel



Frequency Tolerance

The frequency tolerance is the maximum allowable deviation from nominal frequency at a specified temperature. It is normally specified in parts per million (PPM) or % of nominal frequency.

Stability Tolerance

The stability tolerance is the maximum allowable deviation from the frequency at room temperature over a specified temperature range and is expressed in terms of PPM or % of nominal frequency. This factor is dependent upon the angle of cut.

Drive Level

Drive level is the amount of power dissipation experienced by the crystal in a given operating circuit. Drive level is expressed in milliwatts or microwatts. Excessive drive level will result in possible fracture of the quartz resonator or excessive long-term drift. An indication of excessive drive level is a constant frequency drift.

Aging

Quartz crystal aging applies to the cumulative change in frequency which results in a permanent change in operating frequency of the crystal unit. The rate of change of frequency is fastest during the first forty-five days of operation. Many interrelated factors are involved in aging, some of the most common being; internal contamination, excessive drive level, surface change of the crystal, various thermal effects, wire fatigue and frictional wear. Proper circuit design incorporating low operating ambients, minimum drive level, and static pre-aging will greatly reduce all but the most severe aging problems.

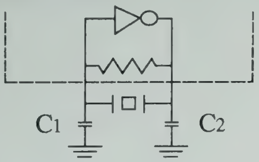
Overtone Crystals

The crystal is usually operated at its fundamental frequency but can be operated on its 3rd, 5th, 7th and 9th harmonics with slight adjustments to the circuit. Overtone crystals are specially processed for plane parallelism and surface finish to enhance its performance at the desired overtone.

How to Specify Load Capacitance

If the oscillator design recommended by the microprocessor manufacturer is as shown in Figure 5, then the crystal is expected to run in its parallel mode. If a series crystal is put in this circuit, the resultant frequency will be high by about 0.02%.

Figure 5
Parallel Oscillator Circuit



The load capacitance can be calculated by the following formula:

$$C_L = \frac{C_1 * C_2}{C_1 + C_2} + C_{stray}$$

Cstray includes pin to pin, input and output capacitance of the microprocessor at the Crystal 1 and Crystal 2 pins plus any additional parasitics. A rule of thumb figure for Cstray is 5 pF; therefore, if $C_1 = C_2 = 50$ pF, C_L would be 30 pF. The effect of load capacitance on frequency is shown in Figure 6.

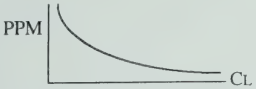
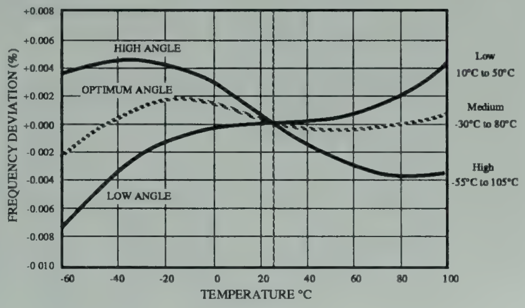


Figure 6
Frequency Change vs CL

Relation of Frequency and Temperature to Angle of Cut

Figure 7



Pullability

The pullability of a crystal refers to a parallel resonant crystal and is a measure of the frequency change as a function of load capacitance. Pullability is important if the designer wishes to have the crystal operate at several other frequencies by means of switching load values.

Pullability is greatly limited in crystals by Co, the shunt capacitance. The pull range for fundamental - mode crystals is approximately:

$$\Delta f_L = \frac{f_{L1}\ C_1\ (C_{T2} - 2\,C_{T1}\,C_{T2})}{2\,C_{T1}\,C_{T2}}$$

where

$$f_{L1} = \frac{1}{2\pi\sqrt{L_1 \frac{C_1\ C_{T1}}{C_1 + C_{T1}}}} = f_r\left[1 + \frac{C_1}{2\,C_{T1}}\right]$$

$C_{T1} = C_0 + C_{L1}$; $C_{T2} = C_0 + C_{L2}$

$C_1 \approx 0.004\ C_0$ (fundamental)

$C_{1\,O.T.} = \frac{C_1}{(\text{overtone})^2}$; overtone = 3, 5, 7, 9

$C_0 \approx 3 \sim 7$ pF

Other important formulae:

$$L_1 = \frac{1}{(2\pi f_s)^2\ C_1}$$

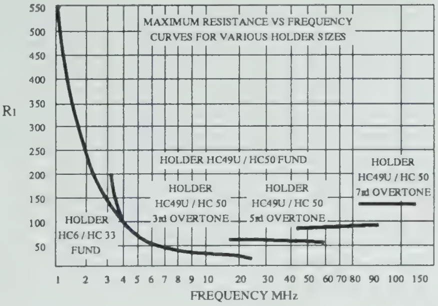
$$f_s = \frac{1}{2\pi\sqrt{L_1 C_1}}$$

$$f_a = \frac{1}{2\pi\sqrt{L_1 \frac{C_1\ C_0}{C_1 + C_0}}}$$

$$R_{Load} = ESR\left(1 + \frac{C_0}{C_L}\right)^2$$

Typical Resistance Characteristics "AT" Cut Crystals

Figure 8



QUALITY AND RELIABILITY

QUALITY SYSTEM

From management to manufacturing, quality is the top priority at Fox. Processes are constantly monitored to ensure Fox products adhere to each specification. Quality products result from a combination of the following:

- RECEIVING INSPECTIONS: All purchased and raw materials are inspected for adherence to specifications determined by engineering.
- INTERNAL QUALITY AUDITS: A periodic inspection of all production areas guarantees compliance with the Fox Quality Assurance Procedure Handbook. Items audited include accordance to electrostatic discharge (ESD) protection, instrument calibration, availability of process instructions, and proper safety precautions.
- OUTGOING QUALITY CONTROL: All parts are tested according to MIL-STD-105, "Sampling procedures and table for inspection by attributes". 100% inspection is also available by customer's request.
- STATISTICAL PROCESS CONTROL (SPC): Outgoing product quality of all standard Fox crystals is monitored by Statistical Process Control Software. Feedback to manufacturing ensures control of equipment and procedure variability. Run charts, data distributions, process capabilities (CpK) and other customer-specific programs are available on request. Contact the SPC Coordinator for more information.

Fox maintains a complete Quality Manual and Quality Assurance Procedure Handbook, and is currently implementing ISO 9000 Qualification Procedures.

RELIABILITY SYSTEM

The quality and long life of the Fox product line in the field is as important as process quality. For this purpose, Fox established the Test and Reliability Department. Technicians and engineers perform stringent tests utilizing advanced environmental chambers and automated test equipment. The main focus is "Accelerated aging", or Mean-Time-To-Failure (MTTF). MTTF is expressed in hours of operation and determines how long a part will last on average. MTTF figures are updated annually, or whenever a new product is designed. For each family of oscillators, the total quantity of devices tested will be cumulative whenever new samples of the same family complete the MTTF evaluation, according to MIL-STD-883C Method 1005.7 Paragraph 3.4

Essentially, MTTF is determined by placing a sample lot of oscillators into an environmental chamber and biasing them at 5.0 Volts. The oven temperature is increased to 125°C and left on for 1000 hours. All failures are noted. Failures due to external causes and not the unit, or failures which are investigated and corrected, are not counted against the MTTF calculation. To determine Mean-Time-To-Failure, the following formulas are utilized:

DEVICE HOURS = NO. OF DEVICES X HOURS AT ELEVATED TEMPERATURE

$$\text{ACCELERATION FACTOR} = e^{\left(\frac{E_A}{k}\left\{\frac{1}{T_1} - \frac{1}{T_2}\right\}\right)}$$

$$\text{MTTF} = \frac{\text{DEVICE HOURS X ACCELERATION FACTOR X 2}}{X^2\ [\text{THETA}, r]}$$

$$\text{FAILURE RATE (LAMBDA)} = \frac{X^2}{\text{DEVICE HOURS X ACCELERATION FACTOR X 2}}$$

FITS = (LAMBDA) X 1E9

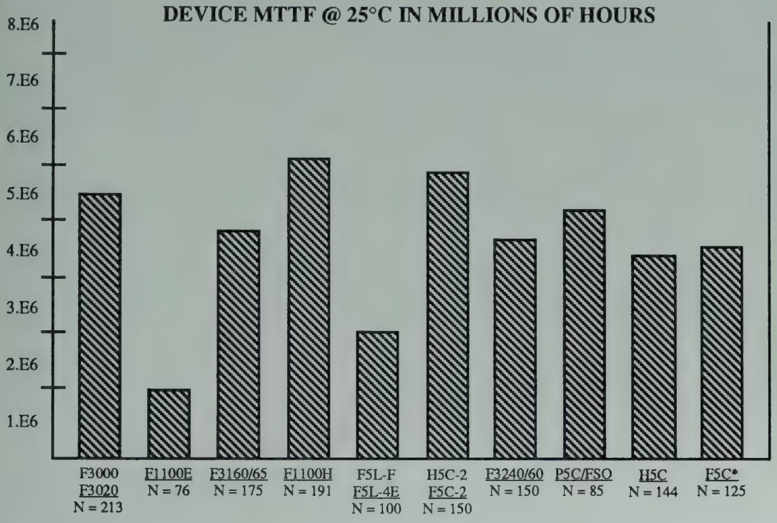
NOTE: THETA = 60% Upper Confidence Limit
r = Number of Failures
EA = 0.4 eV
k = Boltzmann's constant, 8.62×10^{-5} eV/°K
T_1 = 25°C (298 °K)
T_2 = 125°C (398 °K)
X^2 = Chi Square Value

CHI-SQUARE TABLE

CHI-SQUARE DISTRIBUTION FUNCTION			
60% Confidence Level		90% Confidence Level	
No. Fails	X^2 Quantity	No. Fails	X^2 Quantity
0	1.833	0	4.605
1	4.045	1	7.779
2	6.211	2	10.645
3	8.351	3	13.362
4	10.473	4	15.987
5	12.584	5	18.549
6	14.685	6	21.064
7	16.780	7	23.542
8	18.868	8	25.989
9	20.951	9	28.412
10	23.031	10	30.813
11	25.106	11	33.196
12	27.179	12	35.563

QUALITY AND RELIABILITY

(RELIABILITY CONTINUED)


DEVICE MTTF @ 25°C IN MILLIONS OF HOURS

MTTF (million hours)

* F5C = 4.785663

F1100E = 1.233424

F3160/65 = 4.862686

H5C = 4.124386

F5L-F/F5L-4E = 2.472188

F5C-2/H5C-2 = 5.444189

P5C/FSO = 4.637207

F3240/60 = 4.862686

F1100H = 6.020961

F3000/F3020 = 5.468204

* All, or some, devices substituted at 70°C instead of 125°C for 1,000 hours, which results in lower MTTF.
Note that derived values are heavily dependent on sample size and IC logic; i.e..... HCMOS, TTL, ECL etc.
A calculated result of 1 million hours is equal to 114 years of theoretical operation at 25°C.

PRODUCT QUALIFICATION

The Test and Reliability Department is responsible for the evaluation of the complete Fox product line, its specifications, and any new products developed. Reliability of each part family is verified every six months by performing tests according to Table 1 or Table 2.

A qualification occurs when:

- A new product is developed by engineering
- A product design is modified
- A customer requests it

The following procedure details the qualification cycle:

A) Marketing or engineering notifies Test and Reliability of a new or revised product. A product feasibility study is performed.

1) If the product is accepted, Quality Assurance will review production, quality, and Test & Reliability procedures and set up a process schedule for qualification.

2) If the design is not feasible:

a) The design and supporting data will be filed for possible future considerations.
b) The design will be reconsidered after further analysis.

B) A minimum of 25 samples of the new product is required for evaluation.

C) The non-destructive tests are performed on all samples, and are divided into groups according to Table 1 for further testing:
Group A - Electrical Parameters
Group B - Mechanical Tests
Group C - Reliability Tests

D) Upon successful qualification, the new product family is approved and made available for marketing use. Test & Reliability will supply test results to the SPC Coordinator for statistical validity. If failures occur, corrective action is performed. If failure mode is fatal to the product design, qualification is terminated and redesign is necessary.

TABLE 1
RELIABILITY TEST PROCEDURE FOR QUARTZ CRYSTAL OSCILLATORS

Group A (Electrical Parameter, Outline, Structure)

TESTING ITEM	TEST METHOD & PROCEDURE	SPECIFICATION
a) Characteristics at room temperature 25°C	Oscillator test circuit, individual specification	Per individual specification
b) Frequency vs. Temperature	Temperature test circuit (VDD 5.0V ±10%) On-power test Temperature per individual specification	Per individual specification
c) Outline, Marking Dimension	Magnifier per individual specification Calipers, Micrometer	Per individual specification
d) Solvent Resistance	MIL-STD-202F, Method 215B (Test Level S-1 AQL .01)	No deterioration of marking
e) Terminal Strength I (Pull Test)	MIL-STD-202F, Method 211A, test condition A	Meet (h), (i)
f) Terminal Strength II (Bend Test)	MIL-STD-883, Method 2004.4, test condition B1	No distortion of terminals Meet (h), (i)
g) Solderability	MIL-STD-202F, Method 208E	Visually inspected under magnification, at least 95% coverage of continuous new solder
h) Gross Leak	MIL-STD-202F, Method 112D, test condition D	No bubble stream
i) Fine Leak	MIL-STD-202F, Method 112D, test condition C, proc. IIIa	2 x 10^{-8} atm-cm^{3}/sec max
j) DPA (internal inspection)	Microscope	No visual defects

Group B (Mechanical Parameters)

TESTING ITEM	TEST METHOD & PROCEDURE	SPECIFICATION
a) Heat Cycle Test	MIL-STD-883, Method 1010.5, test condition B	Per individual specification
b) Low Temperature Exposure	The specimen shall be allowed to stand in test chamber with the temperature stabilized at -40 ±3°C for 12H	Per individual specification
c) Vibration (1) Sine Wave	MIL-STD-202F, Method 204D, test condition D	Per individual specification
d) Shock (1) 1/2 Sine Wave or (2) Natural Drop	MIL-STD-202F, Method 213B 1000G, 0.35 ms The specimen is allowed to fall freely onto a hard wooden plate 3 times from a height of 75 cm. (JIS - Japanese Industry Standards)	Per individual specification
e) Soldering Heat	Same as solderability (Group A (g)), but temperature is at 270 ±5°C	Per individual specification

Group C (Reliability)

TESTING ITEM	TEST METHOD & PROCEDURE	SPECIFICATION
a) Aging (MTTF calculations)	MIL-STD-883, Method 1005.7	No failures, per individual specification
b) Heat Cycle Test	Temperature: -55 to 125°C for 100 cycles, each 30 min., 1 hour per cycle. (Total 100 hours)	No failures, meet individual specification
c) Thermal Shock	Temperature: 0 to 125°C for 2000 cycles, each 10 min., 20 min. per cycle	No failures, meet individual specification

(TABLE 2)
RELIABILITY TEST PROCEDURE FOR QUARTZ CRYSTALS

Group A (Electrical Parameter, Outline, Structure)

TESTING ITEM	TEST METHOD & PROCEDURE	SPECIFICATION
a) Tensile strength of termination (Pull Test)	MIL-STD-883, Method 2004.4, test condition A	Meet items (k), (1)
b) Bending strength of termination (Bend Test)	MIL-STD-883, Method 2004.4, test condition B $_1$	Visually inspected, no damage allowed - Meet items (k), (1)
c) Solderability	MIL-STD-883, Method 2003.3	Visually inspected under magnification, at least 95% coverage of continuous new solder *Note 2
d) Gross Leak	MIL-STD-202F, Method 112D, test condition D	No bubble stream
e) Fine Leak	MIL-STD-202F, Method 112D, test condition C, proc. IIIa	1 x 10^{-8} atm-cm^3 /sec max
f) Solvent Resistance	MIL-STD-883, Method 2015 (Test Level S-1 AQL .01)	No deterioration of marking

Group B (Mechanical Parameters)

TESTING ITEM	TEST METHOD & PROCEDURE	SPECIFICATION
a) Soldering Heat	Same as solderability (c), but temperature is at 270 ±5°C *Note 1	* Note 2
b) Shock	The specimen is allowed to fall freely onto a hard wooden plate 3 times from a height of 75 cm. (JIS - Japanese Industry Standards)	* Note 2
c) Vibration	The specimen shall be mounted on equipment. The specified class of vibration shall apply per the following: Frequency Range : 10 to 500 Hz Peak-to-Peak Amplitude : 1.5mm or 10G whichever is smaller Rate of Sweeping : 10-500-10 Hz approx. 15 min (logarithmic sweep) Test Duration : 2H	* Note 2
d) Heat Test	The specimen shall be allowed to stand in test chamber with the temperature stabilized at 85 ±3°C for 12H * Note 1	* Note 2
e) Cold Test	Same as Heat Test, but temperature is at -40 ±3°C	* Note 2

Group C (Reliability)

TESTING ITEM	TEST METHOD & PROCEDURE	SPECIFICATION
a) Heat Cycle Test	MIL-STD-883, Method 1010.5 -55°C 15 min, 125°C 15 min * Note 1	* Note 2
b) Aging (MTTF calculations)	MIL-STD-883, Method 1005.7, para. 3.1.1 * Note 1	* Note 2

* Note 1: After completion of test, the specimen shall be allowed to stand under the reference condition for 1H, then measured.
* Note 2: Frequency variance shall be within ±5PPM. ESR variance shall meet specification.

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